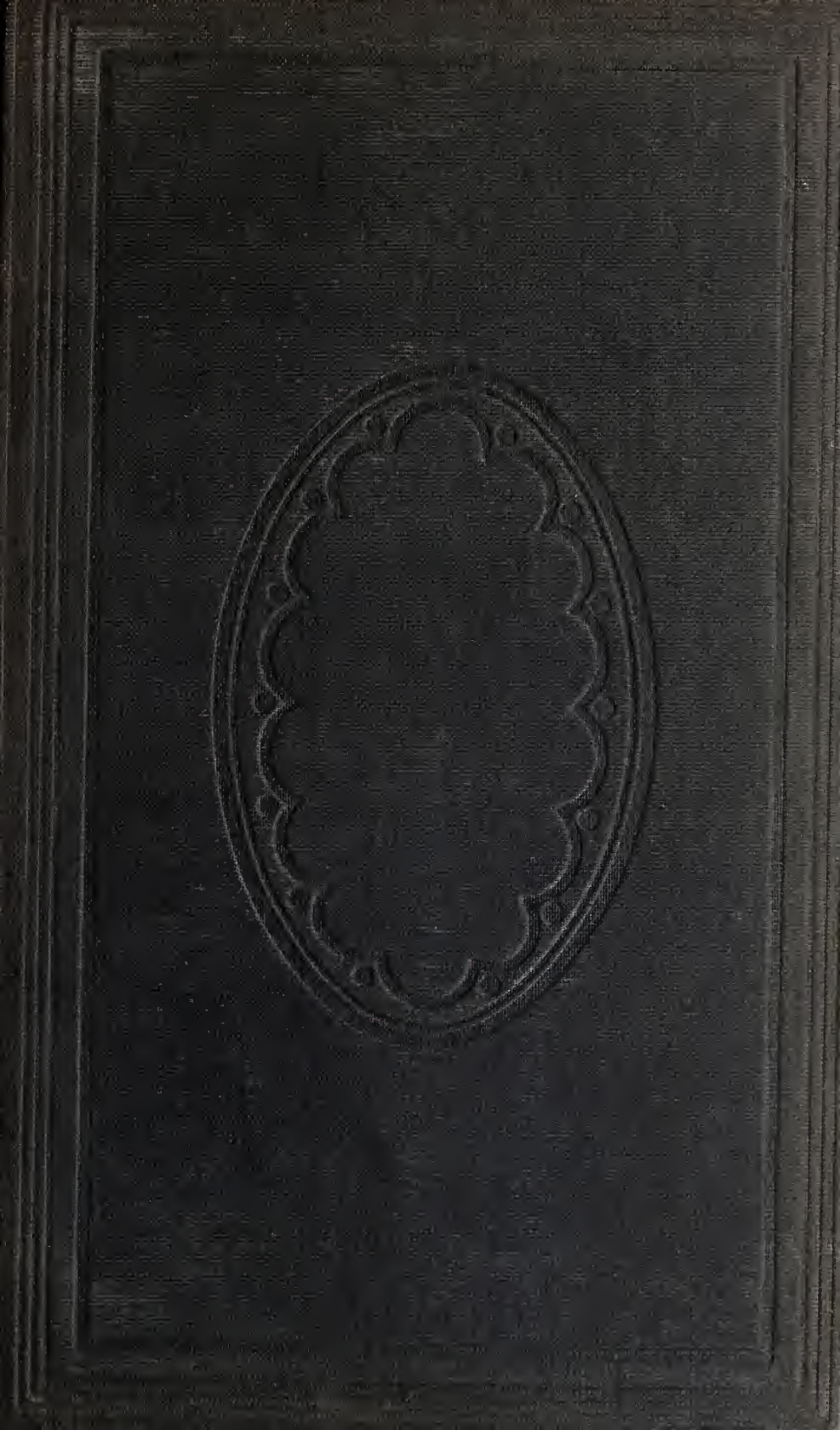


SECOND ANNUAL REPORT

OF THE

STATE BOARD

OF

HEALTH, LUNACY, AND CHARITY

OF MASSACHUSETTS.

1880.

SUPPLEMENT

CONTAINING THE

REPORT AND PAPERS ON PUBLIC HEALTH.

BOSTON:
Rand, Avery, & Co., Printers to the Commonwealth,
117 Franklin Street.
1881.

MEMBERS OF THE BOARD.

1880-1881.

MOSES KIMBALL, Chairman	OF BOSTON.
THOMAS TALBOT, *Chairman*	OF NORTH BILLERICA.
HENRY I. BOWDITCH, M.D.	OF BOSTON.
NATHAN ALLEN, M.D.	OF LOWELL.
CHARLES F. DONNELLY	OF LOWELL.
EDWARD HITCHCOCK, M.D.	OF AMHERST.
ALBERT WOOD, M.D.	OF WORCESTER.
ROBERT T. DAVIS, M.D.	OF FALL RIVER.
JOHN C. HOADLEY, C.E.	OF LAWRENCE.
EZRA PARMENTER, M.D.	OF EAST CAMBRIDGE.
DAVID L. WEBSTER	OF BOSTON.
CHARLES F. FOLSOM, M.D.	OF BOSTON.
CLARA T. LEONARD	OF SPRINGFIELD.
ALFRED HOSMER, M.D.	OF WATERTOWN.
GEORGE P. CARTER	OF CAMBRIDGEPORT.

[Names of *past* members in Italic capitals; of present members, in Roman capitals.]

COMMITTEE ON HEALTH.

ALFRED HOSMER, M.D., *Chairman.*

ROBERT T. DAVIS, M.D.	THOMAS TALBOT.
JOHN C. HOADLEY.	GEORGE P. CARTER.

CONTENTS.

GENERAL REPORT.

The Pollution of Streams.

The investigations begun in 1875 have been continued this year by an examination of the Deerfield and Miller's Rivers basins. The basin of the Deerfield River has an area of six hundred and sixty square miles, and a population of thirty-six to the square mile. The general character of the country drained by the river is mountainous, containing twenty-three towns, nine of which are in the State of Vermont, the rest in Massachusetts. So much of this area as lies in the former State is sparsely settled by a population steadily diminishing in numbers. By the United States census of 1870 the Vermont towns contained 6,275 inhabitants; by the census of 1880 they are reduced to 5,739. The fourteen Massachusetts towns had 18,055 inhabitants by the State census of 1875; by the United States census of 1880, 18,212. The two largest towns in the basin are Deerfield and Greenfield, — the former with 3,543, and the latter with 3,903.

The refuse from manufactories entering the stream in Vermont is insignificant in amount, and in quality not dangerous to health.

The North River, an important tributary to the Deerfield, entering it at Shelburne Falls, also rises in Vermont, and receives no serious contamination until it reaches the town of Coleraine in Massachusetts.

South River, which joins the main stream near Deerfield, is at Conway an object of some complaint on account of the refuse of a woollen-mill which drains into it at that place. Apart from these instances, and the offensive coal-tar from the gas-works at Greenfield, the Deerfield, as a whole, is remarkably free from the contamination of sewage or manufacturing refuse.

With the exception of the careful attempt made at the woolen-mill in Conway to keep out of the stream, by properly

constructed privies, the excrement of the operatives, no provision exists in the manufactories situated on the stream for thus protecting its waters from this most serious form of pollution.

Greenfield has a water-supply and a sewer system discharging into Green River below the town. It is understood that an attempt to utilize this sewage will probably be made. Shelburne Falls has a water-supply, but no system of sewers.

As the gaugings of this river were taken during the months of August and September, 1880, — one of the driest seasons known, — they undoubtedly represent the smallest dry-weather flow. The flow, as thus ascertained, was 234,646,000 gallons. While the good character of the stream as it enters this State is impaired somewhat at two of the manufacturing towns, it still enters the Connecticut River a not highly contaminated stream.

Miller's-river Basin, which has a drainage area of four hundred and ten square miles, and a population per square mile of sixty-six, lies partly in New Hampshire and partly in Massachusetts. The soil in the eastern portion of the basin is swampy; and the river in its whole course is much discolored, both by the peat-bogs and the other beds through which it passes. The head-waters are large ponds in Rindge, N.H., and in Ashburnham, Mass. Otter River, which enters Miller's River above the town of South Royalston, brings from the town of Gardner, in which it rises, a very large amount of polluting substances. The rapid growth of this busy manufacturing town has had a disastrous influence upon the purity of this stream. About thirteen hundred persons are employed in factories draining into it in the town of Gardner alone; the privies here, as in almost all the factories on the river, being placed directly over the stream.

The three New Hampshire towns within whose limits the river lies in that State had 3,115 inhabitants in 1870, and in 1880 had fallen to 2,792. The Massachusetts towns had, on the contrary, increased in the years, from 1875 to 1880, from 22,995 to 24,516. The principal manufacturing towns in the basin are Winchendon, Gardner, Athol, Orange, and the village of Miller's Falls.

The river is not itself used as a source of domestic water-supply, nor is it likely to be so used in the future. The only

towns at present provided with public water-supply are Athol and the village of Miller's Falls, though Gardner is on the point of taking a supply from Crystal Lake. The springs in Phillipston, from which is derived the supply of Athol, have been hitherto supposed to furnish a water of very good quality; but in the last year or two the condition of the main reservoir has become objectionable. No provision has been made for draining the town, however; and the condition of the shallow pond in the heart of it is quite foul, and a standing menace to the health of the inhabitants.

Gardner, the largest town in the basin, depends entirely upon wells and cisterns for a domestic water-supply. Many of the former are dangerously near contaminating influences, and in more than one instance seem to have been the active agents in transmitting disease. Here, as in the case of the Deerfield River, the gaugings of daily flow were made in the exceptionally dry year of 1880; and the result, 169,646,000 gallons, is held by those most familiar with the stream to represent its lowest dry-weather flow.

An unnecessarily large amount of excrement and refuse matter is now admitted to the stream, which might at a very moderate expense be otherwise provided for, inasmuch as legislative action will probably never be asked for to protect the stream sufficiently to make it a source of domestic water-supply.

With the consideration of these two rivers, the investigations begun in 1875 are now practically complete, except as to the Merrimac and Connecticut. In the case of these streams, all has been done that can be profitably done within the limits of this State; and there seems at present little to be gained by the necessarily expensive examinations that would have to be carried on outside the State.

Food.

No paper is offered upon this subject this year. The examination of hogs is still going on, in order to correct, if necessary, the results obtained by the examinations made in 1879.

Mr. W. K. Robbins, who made some analyses of various food materials during the months of June, July, and August, submits the following statement: —

"One hundred and three samples of bread were tested for *alum*. Of these, 7 were known to contain it, and 2 known to be free from it; of the remaining number, 7 contained a very small quantity less than one-tenth of one per cent, and 88 were entirely free from it.

"These 95 samples were purchased from as many different *bakehouses* in the city, without it being known to the baker for what purpose the bread was to be used. Twenty of these samples were also incinerated, and the ash examined for other mineral adulteration; but none was found. All the bread examined looked, smelled, and tasted well.

"Quite a variation in size of the five-cent loaf led to the weighing of 42 loaves as soon as they were received. The smallest weighed 229 grams, the largest 489 grams; 10 weighed more than 400 grams each, and 9 weighed less than 300 grams. The moisture was estimated in 13 samples, and varied from 31.42 per cent to 65.27 per cent. Only 4 of these contained over 38 per cent. The 2 samples of ordinary home-made bread gave respectively 38.39 per cent and 35.73 per cent; and the average of all gave 41.26 per cent.

"The fat was estimated in home-made and in bakers' bread. The 2 samples of home-made gave 1.12 per cent and 1.17 per cent; 4 of bakers' gave 1.33 per cent, 1.34 per cent, 1.10 per cent, and 2.10 per cent. This would show that there is no important difference in the amount of moisture and fat in bakers' bread and that ordinarily made in families.

"Ten samples of crackers were examined, and no mineral adulteration found. Three sirups were examined: they all contained lime and sulphuric acid, but in such small quantities as not to be worthy the name of adulteration. Two of them contained dextrine, which would indicate their containing sirup made from starch.

"Perhaps it would be well to state that the 'logwood solution' was used in testing for alum. This, though criticised by some, never failed to show alum when it was known to be present; and it is so delicate that it will show the presence of less than one part in ten thousand of crystallized alum in bread, and will do this even after the bread has been baked a month, and has become covered with mould.

"This I proved by the following experiment: samples of pure flour that had been tested were mixed with known amounts of alum, and baked in the ordinary way, taking special care that no alum was introduced. The test worked very satisfactorily, both upon the samples of flour thus prepared and the bread which had been made from them: hence I think the test a reliable one."

So far as these examinations go, there seems to have been no serious adulteration discovered.

Sewerage.

The recent construction at Memphis of a system of small sewers, from which surface and roof water are entirely excluded, has given rise to much discussion upon the relative merits of the combined and separate systems of sewerage.

Mr. Clarke has prepared a well-considered statement of this question, and arrives at the following conclusions: that a separate system of sewage is only necessary where cellars are so low that they must be drained by pumping; that in other cases its only merit is its cheapness; that the saving in first cost of sewers, where all of the rain flows off over the ground, will be about three-fifths, depending on the character of the soil; that the final economy will depend on circumstances; that the system would only be advisable where the branch sewers could incline not much less than one in one hundred; that surface drainage for rain is attended by a varying amount of inconvenience and damage, which increases with the growth of a town.

In the dissimilar conditions affecting towns and cities is found sufficient reason for difference in methods of sewer-construction; where it is necessary to carry off storm-water underground from closely built-up and densely populated districts, and where new sewers must be constructed for the purpose, the combined system is evidently the most economical.

When storm-waters can be provided for by an existing system of sewers, which has become unsuitable for the proper conveyance of sewage, or when there is no objection to the presence of this water on the surface of the ground, or immediately below it, a separate system may prove to be cheaper.

Again, it may be advisable in some districts to combine the two systems. But these are all questions to be determined only by a competent engineer in full possession of all the facts in regard to the district to be sewered.

Memphis remains the only city in the United States in which the separate system has been completely adopted; and it is yet too early to claim for it entire success.

Intermittent Fever.

Malarial fever, appearing both as an endemic and epidemic, covers a vast portion of the earth's surface. In the regions about the equator it is a disease of great severity, and extends with diminishing violence through the temperate zone, sometimes spreading as an epidemic through regions where it has not for many years been known.

None of the many conditions which have been assumed to be explanations of the occurrence of this disease are indispensable. It may occur upon a dry as well as upon a damp soil, on a hill or in a valley, on a bed of gravel or in a rich alluvial river bottom.

The assumption that rapid changes of temperature, in connection with a moist atmosphere, are necessary factors, is also unfounded.

No better evidence of the insufficiency of our real knowledge upon this subject can be found than the impossibility of determining the conditions which have necessarily accompanied the re-appearance of intermittent fever in certain parts of Massachusetts after an absence of three-quarters of a century.

Intermittent fever, which, since 1850, has been more or less prevalent in Connecticut, was in recent years practically unknown in this State until it crossed the border-line in 1877 at Sheffield. The few cases that had appeared in two or three Connecticut-river cities and towns before that year, and since 1870, had attracted no general attention. Since 1877 it has made very rapid progress throughout the western part of the State. Dr. J. F. A. Adams of Pittsfield has therefore undertaken an inquiry into the history and conditions of this new outbreak of an old disease.

Dr. O. W. Holmes had, in 1836, published his account of intermittent fever in the New England States.[1] At the time the essay was written the disease had become almost unknown, the periods of its prevalence having been of much earlier date.

Dr. George Derby, in the report of the State Board of Health for 1872, stated his belief that the territorial line of demarcation (always ill defined) between fevers of a continued and of a periodic type is extending northward, and that our immunity from remittents and intermittents is far less complete than in previous generations.

The present paper is founded upon an almost exhaustive series of returns of one sort or another from all parts of the State, and will prove, it is hoped, only the beginning of a systematic inquiry on the part of health boards, with larger

[1] Facts and Traditions respecting the Existence of Indigenous Intermittent Fever in New England. Boylston Prize Essay, 1836.

territorial control than this, into the varying appearances of a disease of which we can say, as truly now as Hirsch did twenty years ago, "If we assume that a definite organic or inorganic principle is the foundation of a case of malarial fever, — and to such a view we seem to be driven by the similarity of the disease processes at all times and in all places, — and admitting, in view of all the facts in the history of the disease, that the external conditions exercise a more or less important influence upon the occurrence and geographical spread of malarial fever, — we must still acknowledge, that in these conditions alone is not to be sought the real source of that definite principle; and that, in this respect, we are at present thrown back upon that '*quid divinum*' of Hippocrates, for which modern science has found so many other designations and representations, but not yet a sufficient explanation."

Sanitation of Public Schools.

This topic has already been twice the subject of special papers in the reports of the State Board of Health. The first was prepared by Dr. Winsor for the report of 1874, and was devoted mainly to an investigation of the evils resulting from study, either excessive or ill directed; the second, by Dr. D. F. Lincoln, contained the results of an inquiry into the site, construction, sewerage, drainage, and ventilation of schoolhouses, together with the question of the transmission of contagious diseases by schools. This appeared in the report for 1878.

The facts brought together in Dr. Lincoln's paper were obtained by addressing a circular of inquiries to the medical correspondents of the Board, and to a number of teachers in this State.

E. W. Bowditch, C.E., has in person examined the schoolhouses of certain cities of the Commonwealth, and has in his report given a statement of their condition.

The number of cities in which this minute examination could be carried on was necessarily small; but there is no reason to suppose that the schoolhouses of the cities mentioned in the report are better or worse than those not here included. The cities selected were chosen because they were believed to be representative of varied interests, and not because it was expected to find in them defective schoolbuildings.

Dr. Lincoln stated the points which should be attended to in framing rules for preventing the spread of contagious diseases in schools to be five: —

1. *Vaccination.* — A certificate to be required of every child entering the public schools, as is the law now in Massachusetts.

2. Physicians to be required under penalties to report to local Boards of Health all cases of dangerous infectious diseases observed by them, the Board to inform principals of schools.

3. The existence of any case of such diseases in a house to exclude the inmates from attendance at schools for a sufficient length of time, the propriety of re-admission to being certified to by a competent physician.

4. Disinfection of premises and clothing, by the Board of Health, in every house where the above diseases have prevailed.

5. Medical authority to be designated for the purpose of advising teachers and pupils, and pointing out to the school committee matters in regard to which their authority might be used to improve the sanitary condition of schools.

Of these rules the four first named are understood to be substantially in force in the city of Boston; and the last one seems to have failed of adoption in the above-named city, only from the difficulty of selecting one from a number of candidates for a position corresponding very nearly to that described in this rule.

Competent local Boards of Health can exercise the more important functions designated in Rule No. 5, and in some cases have already done so in more than one city or town.

Health of Towns.

The town of Adams was on 15th June, 1880, visited by an epidemic disease of unusual kind. No satisfactory explanation of it could then be given; and, in spite of the manifest difficulties of an investigation carried on weeks after the disease had disappeared, Dr. Adams has brought together a collection of facts which establish a more direct relation with the water-supply of the town than with any other circumstance noted in connection with this startling but happily not fatal epidemic.

The death-rates of the city of Holyoke, as given in the Registration Reports of the State, have for a number of years attracted attention to their high percentages. With the hope of gaining some explanation of this high death-rate, a very careful sanitary survey of the city was made during the summer and autumn of 1880, under the local direction of Dr. J. J. O'Connor of Holyoke, with blanks prepared in the office of the Health Department. The facts obtained from an inspection of these returns are exhibited in a series of admirable charts prepared by E. W. Bowditch, C.E.

It may be added that the returns of the last twelve months have shown a very much better condition of health in this city, although its most serious defect — crowded tenement-houses — has probably been removed to a very slight extent. Holyoke has had, however, during these last months, the assistance of a very able and devoted Board of Health; and no small portion of the credit for the much improved sanitary state of the city belongs to this new organization.

Small-Pox and the Neglect of Vaccination.

Outbreaks of small-pox occurred in two cities in the State, but were easily controlled, and were in general limited to the few individuals at first attacked.

The increasing prevalence, however, of this disease in Philadelphia and New York is a warning to health authorities of State and town to see that vaccination of all unprotected individuals is promptly performed. Inquiry and inspection in many towns have shown that the provisions of the statutes in respect to vaccination have been much neglected. And there has been also found an occasional expression of doubt as to its value as a protection. Dr. Buchanan of London, the medical officer of the Local Government Board, has in a recent memorandum made the following statement as to the value of vaccination in London: —

"*Comparative Small-Pox Death-Rates among Londoners Vaccinated and Unvaccinated respectively for the Fifty-two Weeks ended May 29, 1881.*

Death-Rate of People of Subjoined Ages.	Per Million of each Age of the Vaccinated Class.	Per Million of each Age of the Unvaccinated Class.
All ages	90	3,350
Under 20 years	61	4,520
Under 5 years	40½	5,950

"I proceed to consider what lessons are to be learned from the above.

"(*a*) As no one suggests that the vaccinated and unvaccinated classes live under conditions differing from each other in their influence on small-pox, unless it be this one condition of vaccination, it follows for a first inference that the vaccinated are much less liable to die of small-pox than the unvaccinated.

"(*b*) The second lesson is, that vaccination is not an absolute protection against small-pox.

"For (*c*) the third lesson derivable from the figures above tabulated (and bearing upon the foregoing point), is, that the degree of protection, both actual and relative, afforded by vaccination, is greatest to people under five years of age; less when ages from birth to twenty are examined; and still less when people of all ages are taken into the account. Thus, the distance of time from the operation appears to be concerned with the degree of its protective powers.

"The foregoing lessons from the registrar-general's returns are nowise new; but they are taught afresh by to-day's experience among our own selves in London, and they would appear, therefore, to be worth bringing to the notice of people who are trusting to chance for the escape of their children and themselves from the distressing, disfiguring, and fatal disease of small-pox. Londoners can, by availing themselves of one average vaccination, diminish the chances of their children dying of small-pox in the proportion of a hundred and forty-six to one for the first five years of their life; and the same vaccination serves to lessen, in the proportion of seventy-four to one, the chance of their being killed by the disease before they reach the age of twenty. After that age the vaccination in infancy is further reduced in its protective influence; for the difference in small-pox mortality between the unvaccinated and the vaccinated class through the whole period of life is as one to thirty-seven, — a protection incomplete, indeed, but obviously important for every one to possess. You will observe that I have not said a word on the need for a second vaccination of people after the age of infancy; but no question of re-vaccination is concerned in the foregoing general conclusions, nor to any appreciable degree in the tabulated figures.

"The evidence now appearing as to the diminished potency of vaccination to prevent persons of later age dying of small-pox is entirely in harmony with the abundant evidence which we possess of the great additional immunity from small-pox conferred by a second vaccination upon soldiers, sailors, postmen, persons employed in small-pox hospitals, and upon others; and, indeed, if we had nothing but the present figures before us, they must be regarded as pointing strongly to a need for repeating vaccination as age advances. Nor have I yet made any mention of the thoroughness of vaccination as affecting the protection against small-pox that the operation can give. It will be enough here to recall that every thing passing under the name of "vaccination" is not of the same avail as a protection against small-pox. Facts and figures derived from experiences other than those which I am now reviewing prove, that, even when vaccinated persons have contracted small-pox, those who are thoroughly well vaccinated have twenty-fold the advantage over those

who have been very badly vaccinated in respect of their chances of recovery. I append a copy of the paper upon this subject that is in common use by the Board. The recent registration returns, however, and the comments I have made upon them, have been content to place every thing that could be spoken of as "vaccination," perfect and imperfect together, in the same category. You are aware that I am now engaged, with Dr. Stevens's assistance, in some inquiries into the relative protective influence of one and another sort of vaccination during the present small-pox epidemic in London; and I trust that on some early occasion I may be able to lay before you some facts on this subject also."

Dr. Z. B. Adams has contributed a paper, showing that, in his own experience, in one town at least, the laws as to vaccination have not been complied with, and has set forth again the horrors of small-pox and the benefits of vaccination. The plan which he proposes — corresponding closely with what has seemed practicable to many of those who have made a lifelong study of this subject — is not regarded by this Board as at present necessary, though many of its features are to be commended. The present laws of the State, if enforced, seem to us sufficient.

The Metric System.

Length.

1 Myriameter .	. Mm.	(10,000 m.)	= 6.2137 miles.
1 Kilometer .	. Km.	(1,000 m.)	= 0.62137 mile.
1 Hectometer .	. Hm.	(100 m.)	= 328.0833 feet.
1 Decameter .	. Dm.	(10 m.)	= 393.7 inches.
1 Meter . .	. m.	(1 m.)	= 39.37 inches.
1 Decimeter .	. dm.	(0.1 m.)	= 3.937 inches.
1 Centimeter .	. cm.	(0.01 m.)	= 0.3937 inch.
1 Millimeter .	. mm.	(0.001 m.)	= 0.03937 inch.

Surface.

1 Hectare . .	. Ha.	(10,000 sq. m.)	= 2.471 acres.
1 Are . .	. a.	(100 sq. m.)	= 119.6 square yards.
1 Centare . .	. ca.	(1 sq. m.)	= 1.550 square inches.

Capacity.

1 Kiloliter or Stère .	Kl. or st.	(1,000 l.)	= 1.308 cubic yards	= 264.17 gallons.
1 Hectoliter .	. Hl.	(100 l.)	= 2 bushs. and 3.35 pecks	= 26.417 gallons.
1 Decaliter .	. Dl.	(10 l.)	= 9.08 quarts	= 2.6417 gallons.
1 Liter . .	. l.	(1 l.)	= 0.908 quart	= 1.0567 qts. (1.761 imperial pints.)
1 Deciliter .	. dl.	(0.1 l.)	= 6.1022 cubic inches	= 0.845 gill.
1 Centiliter .	. cl.	(0.01 l.)	= 0.61022 cubic inch	= 0.338 fluid ounce.
1 Millimeter .	. ml.	(0.001 l.)	= 0.061 cubic inch	= 0.27 fluid drachm.

Weight.

1 Millier or Tonneau,	M. or T.	(1,000 Kg.)	= 1 Kl. or 1 Cu. m.	= 2204.6 pounds (avoirdupois.)
1 Quintal . .	. Q.	(100 Kg.)	= 1 Hl. or 0.1 Cu. m.	= 220.46 pounds.
1 Myriagram .	. Mg.	(10 Kg.)	= 1 Dl. or 10 Cu. dm.	= 22.046 pounds.
1 Kilogram .	. Kg.	(1,000 g.)	= 1 l. or 1 Cu. dm.	= 2.2046 pounds.
1 Hectogram .	. Hg.	(100 g.)	= 1 dl. or 0.1 Cu. dm.	= 3.5274 ounces.
1 Decagram .	. Dg.	(10 g.)	= 1 cl. or 10 Cu. cm.	= 0.3527 ounce.
1 Gram . .	. g.	(1 g.)	= 1 ml or 1 Cu. cm.	= 15.432 grains.
1 Decigram .	. dg.	(0.1 g.)	= 0.1 ml. or 0.1 Cu. cm.	= 1.5432 grains.
1 Centigram .	. cg.	(0.01 g.)	= 0.01 ml. or 10 Cu. mm.	= 0.1543 grain.
1 Milligram .	. mg.	(0.001 g.)	= 0.001 ml. or 1 Cu. mm.	= 0.0154 grain.

One kilogram is equal to a weight represented by one liter of distilled water at 4° C. In the centigrade scale 0 (32° + F.) is the freezing-point; 100° + (212° + F.) is the boiling-point. Five degrees C. corresponds to nine degrees F.

All measures in the metric system are derived from the meter, and their names express their values. Some of the names in the French system (like our "dime") are not in practical use; e.g., hectometer, decagram, etc.

One inch = 2.5 centimeters nearly; one quart (wine measure) = 0.946 liter; one pound Troy = 0.373 kilogram; one acre = 0.4046 hectare.

THE POLLUTION OF STREAMS.

THE DEERFIELD AND MILLER'S RIVERS.

BY

W. E. HOYT, C.E.

DEERFIELD RIVER,

Compiled from Walling's Maps

Drainage Area, total, 660 *Sq Miles,*
in Massachusetts, 334 "

Woolen Mills,	■
Cotton "	▪
Machine Shops and Cutlery Works,	★
Tanneries,	▲
Foundries,	♂
Gas Works,	♨

Miles.

Kilometres.

Notes.

The figures, thus 12 *show the available fall at each dam. The letters are referred to in the tables of analyses and statistics.*

Stratton
Deerfield River
Somerset.
East Branch
Dover.
Wilmington.
Searsburg.
Marlboro
Haztwellville
West Branch
Jacksonville
Sadoga Pond
Whittingham
Halifax.
North River
Readsboro.
VERMONT.
Munroe
Florida.
Rowe.
Tatham Brook
Heath
West Branch
Colerain
Leyden
Griswoldville
Green River
Mill Brook
Gold River
Zoar
Mill River
Shattuckville
North River
Charlemont
Deerfield River
Shelburne Falls.
Savoy.
Cheshire River
Clesson Brook
Buckland
Greenfield
Hawley.
Bear River
South River
Deerfield
Ashfield Plain
South River
Conway

H. B. ELLIS, PHOTO-LITH. BOSTON.

THE DEERFIELD RIVER.

The Deerfield River rises in the town of Stratton, Vt., twenty-five miles north of the Massachusetts State line. Its direction is at first southerly, until it reaches the western portal of the Hoosac Tunnel, whence it takes an easterly direction for a distance of seventeen miles, to Shelburne Falls. Thence it runs south-easterly to Deerfield; and from this town it flows northerly and easterly to the Connecticut River, joining it a few miles east of the town of Greenfield.

The entire portion of the river within the State of Massachusetts is in Franklin County, with the exception of a few miles near the entrance of the Hoosac Tunnel, where the river itself forms the boundary-line for a short distance between Berkshire and Franklin Counties.

In Vermont the Deerfield flows through a rugged, mountainous country, thinly settled, and devoted very little to either farming or manufactures. Through the towns of Stratton, Somerset, Searsburg, and Wilmington, we find it a stream of inconsiderable size, with only a few saw-mills here and there along its course. Whitingham, the next town below, has a wool-carding mill on a small tributary to the river, flowing from Sadagua Pond. This mill employs but one man, and is kept running only a portion of the year. Four miles below is Readsborough, which has one tannery and currying-shop, employing twenty men, and using three cords of bark per day.

Hartwellville, close by the west branch, has one wood-working shop, with six men employed.

From Readsborough to Hoosac Tunnel, the river has an extremely rapid descent, and rushes down with great velo-

city through steep rocky valleys, frequently forming rapids and waterfalls over the numerous bowlders in its bed. Even in summer, when the water is low, the roar of the stream can be heard at a considerable distance away. Whatever impurities enter the river from the tannery in Readsborough must very soon be rendered harmless by the thorough aëration which the water receives in tumbling and leaping along over the rocks below. Down to this point trout are abundant, and pickerel and dace are also found in the river; but at Hoosac Tunnel, with the widening of the stream as it enters broader valleys, the trout become less frequent. At Zoar, five miles east of Hoosac Tunnel, there is a deposit of sawdust in the river near a sharp bend. This comes apparently from a saw-mill on Pelham Brook, about a mile above. This brook has also a tannery four miles from its mouth, where three men are employed for a portion of the year only.

Flowing easterly through the town of Charlemont, the Deerfield receives numerous affluents from the south, draining the town of Florida, a portion of Savoy, and almost the entire area of Hawley and Buckland. From the north several brooks flow in, draining the towns of Rowe and Heath. On these streams there are no factories, and the towns themselves are thinly settled.

At Shelburne Falls, seventeen miles from Hoosac Mountain, the Deerfield receives an important tributary called North River. This rises in Whitingham, Vt., only a few miles east from the course of the Deerfield River through that town, and flows southerly and easterly, draining a large part of Halifax in Vermont and Colerain in Massachusetts. Near the source of North River in Jacksonville, Vt., is a tannery employing fifteen hands, and using a cord and a half of bark per day. And in West Halifax, on a branch of the same river, is another tannery, with thirteen hands employed: here two cords of bark per day are used, and one hundred pounds of lime.

Six miles from the mouth of North River is a cotton-mill in Colerain; and two miles down the stream is another cotton-mill, in the village of Griswoldville. These mills run 17,000 spindles and 392 looms, and employ 250 persons. A little farther down North River is a cotton-mill at Shat-

tuckville, running 5,830 spindles and 178 looms. This mill employs 100 hands. Just above the mouth of the river is still another cotton-mill, running 2,200 spindles and 64 looms, with 40 operatives employed.

At Shelburne Falls, a town of sixteen hundred inhabitants, we find a partial water-supply, but no system of sewerage beyond that afforded by one small brook, receiving a few drains from perhaps a dozen houses and stores. Here there is a large dam, built entirely across Deerfield River, which furnishes power for the large cutlery-works of the Lamson & Goodnow Company, as well as smaller cutlery and tool works on the opposite side of the river. These works together furnish employment to four hundred persons, and consume a ton and a quarter of steel per day. There is also a small tannery and currying-shop here, employing only three men, and using one-quarter of a cord of bark per day.

A few miles west of the town of Deerfield, South River, draining the towns of Ashfield and Conway, flows into Deerfield River. At Conway are three cotton-mills and one woollen-mill. The latter produces 1,000 yards of cloth per day, and has eight sets of machinery, with 112 hands. Considerable dyeing and scouring is done in the mill, and the water for quite a distance below is at times much discolored. Complaint is made also of offensive smell from the water in very warm weather.

The cotton-mills run altogether 4,800 spindles, and employ about 100 hands.

Coming next to the town of Greenfield, on Green River, we find a good water-supply and a system of sewerage partly completed. Greenfield has four thousand inhabitants. The Green River rises in Marlborough, Vt., ten miles north of Massachusetts, and flows almost southerly through Guildford, Vt., and Leyden, Mass., before reaching Greenfield. On Mill Brook, in the northern part of Greenfield, is a tannery employing only six men, and using three-quarters of a cord of bark per day. At the mouth of this brook is a manufactory of carriage-irons, employing twenty-five men, and using twenty pounds of sulphuric acid and sixteen pounds of muriatic acid daily.

In Greenfield are also three tool-factories, a large establishment manufacturing cutlery, another manufactory of

carriage-irons, a foundery, and the gas-company's works. These establishments employ in all 217 men, and from them there is some pollution of the river. Below the gas-works, a slight discoloration of the water is seen for a short distance; and a considerable amount of coal-tar floats on the surface, forming a thick deposit in many places along the banks, and on the dams farther down the river.

The Deerfield is a clear, rapid stream throughout its length. The country drained by it is mountainous, with an abundance of pure water everywhere, and good natural surface drainage. The soil in the valleys is alluvial and rich, producing large crops of tobacco. On account of the great amount of rocky and unproductive land, the population of the Deerfield Basin is scattered, and nowhere dense. Greenfield, Deerfield, and Shelburne Falls are the only towns of considerable size within its limits; and it is not likely that the natural increase of population within the next twenty years, even in these towns, will result in any sensible pollution of the river.

At present there is some complaint in Conway on account of the refuse from the woollen-mill draining into South River; and at Greenfield, the coal-tar from the gas-works is offensive: but, aside from these cases, the Deerfield and its tributaries appear to be remarkably free from contamination by town-sewage or factory-refuse.

The privies of the mills along the river are, for the most part, directly over the water; and no attempt is made to utilize the excrement of the operatives, except at the woollen-mill in Conway, where the privies are kept constantly supplied with dry earth to cover the fæcal matter, and the contents are frequently removed, to be hauled away and used as a fertilizer.

Water-Supply and Sewerage.

Both Shelburne Falls and Greenfield have a water-supply, but that at Shelburne Falls is not supplemented by a system of sewers. At a very trifling expense the thickly-settled portion of the town could be easily drained.

The water for Greenfield is obtained from springs in Leyden. The supply is abundant and of excellent quality.

By way of drainage, the town has one main sewer of

brick, 1,600 feet long and 30 inches in diameter. This is to be completed immediately to a length of 3,200 feet. The branches are of Akron pipe, 10 and 12 inches in diameter. The sewers discharge into Green River below the town. A plan for utilizing the sewage has been proposed by J. W. Miller of Greenfield, who is to be allowed to make the experiment for a limited time at his own expense.

TABLE I. — *Population of Towns in the Deerfield Basin.*

MASSACHUSETTS TOWNS.	Population, 1865.	Population, 1875.	Population, 1880. (U.S. Census.)
Ashfield	1,221	1,190	1,062
Buckland	1,922	1,921	1,739
Charlemont	994	1,029	932
Colerain	1,726	1,699	1,777
Conway	1,538	1,452	1,760
Deerfield	3,038	3,414	3,543
Florida	1,173*	572	459
Greenfield	3,211	3,540	3,903
Hawley	687	588	592
Heath	642	545	560
Leyden	592	524	507
Monroe	191	190	166
Rowe	563	661	502
Savoy	866	730	710
Total	18,364	18,055	18,212

VERMONT TOWNS.	Population, 1865.	Population, 1870. (U.S. Census.)	Population, 1880. (U.S. Census.)
Dover	–	635	621
Halifax	–	1,029	851
Marlborough	–	665	553
Readsborough	–	828	743
Searsburg	–	235	232
Somerset	–	80	67
Stratton	–	294	302
Whitingham	–	1,263	1,240
Wilmington	–	1,246	1,130
Total	–	6,275	5,739

* The population of Florida was largely increased for a number of years by the workmen employed in the Hoosac Tunnel.

TABLE II. — *Polluting Factories in Deerfield River Basin.*

NAME OF RIVER OR STREAM.	DESCRIPTION OF MILL.	LOCATION.	Head and Fall, in ft.	Number of hands employed.	Quantity of Materials used per Day.
West Branch	Tannery	Readsborough	15	20	120 pounds lime, $\frac{1}{2}$ bushel hen-manure, 3 cords bark.
North River	"	Jacksonville	14	15	33 pounds lime, $\frac{1}{10}$ bushel hen-manure, $1\frac{1}{2}$ cords bark.
"	"	West Halifax	12	13	100 pounds lime, $\frac{1}{4}$ bushel hen-manure, 2 cords bark.
Pelham Brook	"	Rowe	10	3	15 pounds lime, $\frac{1}{20}$ bushel hen-manure, $\frac{3}{4}$ cord bark.
North River	Cotton-mill	Griswoldville	35	125	1,250 pounds cotton, 80 pounds starch.
"	"	"	24	125	1,330 pounds cotton, 80 pounds starch.
"	"	Shattuckville	32	100	1,000 pounds cotton, 12 pounds starch.
"	"	Shelburne Falls,	22	40	417 pounds cotton.
South River	Woollen-mill	Conway	18	112	1,600 pounds wool, 260 pounds logwood, 26 pounds salt, 40 pounds soda-ash, 83 pounds fustic, 26 pounds madder, 20 pounds camwood, 13 pounds chrome, 3 pounds blue vitriol, 3 pounds red tartar, 2 pounds nitric acid, 2 pounds muriatic acid, 1 pound sulphuric acid, and other dyestuffs to the number of thirty in all.
"	Cotton-mill	"	25	40	1,170 pounds cotton, 83 pounds starch, $1\frac{1}{3}$ pound glue.
"	"	"	20	40	1,000 pounds cotton.
"	"	"	20	15	500 pounds cotton.
Deerfield River	Cutlery-works	Shelburne Falls,	22	280	1 ton steel, 1 ton coal, 3 pounds sulphuric acid.
"	Tool-factory	" "	8	35	120 pounds steel, $\frac{1}{6}$ ton coal, emery, potash, etc.
"	Cutlery-works	" "	22	80	350 pounds steel, 175 pounds iron, 20 pounds brass, six pounds sulphuric acid, $\frac{1}{4}$ ton coal.
"	Tannery	" "	22	3	17 pounds lime, $\frac{1}{30}$ bushel hen-manure, $\frac{1}{4}$ cord bark.
Mill Brook	"	Greenfield	10	6	10 pounds lime, $\frac{1}{40}$ bushel hen-manure, $\frac{3}{4}$ cord bark.
"	Carriage-irons	"	32	25	875 pounds iron, 70 pounds steel, 23 pounds sulphuric acid, 16 pounds muriatic acid, 34 pounds plate tin.

Green River	Cutlery-works	"	"	30		175 pounds steel, ¾ ton coal.
"	Carriage-irons	"	"	20		400 pounds iron, 13 pounds sulphuric acid, 5 pounds muriatic acid, sal ammoniac.
"	Tool-factory	"	"	90		800 pounds steel, 400 pounds iron.
"	Tool-factory and foundery	"	"	50		80 pounds steel, 100 pounds iron.
"	Tool-factory	"	"	25		40 pounds steel, 160 pounds iron.
"	Gas-works	"	"	2		1 ton coal, 2 bushels lime, 2 barrels of water used in washing gas.

TABLE III. — *Summary of Manufactures.*

	Number.	Operatives Employed.		Number.	Operatives Employed.
Woollen-mills .	1	112	Machine-shops and		
Cotton-mills .	7	484	founderies .	6	245
Tanneries . .	6	60	Gas-works . .	1	2
Cutlery-works .	3	390			
			Total . .	24	1,293

The river was carefully gauged at various points, indicated by letters on the map, and the flow of water calculated, as shown in the following table. The measurements were made during the months of August and September, 1880, after an exceptionally dry season, in which very little rain fell throughout New England. Mill-owners and manufacturers reported the river at that time lower than they had ever known it to be previously. The figures in the table may therefore be safely taken as representing quite closely the extreme dry-weather flow of the stream, which of course is very irregular in a mountainous district like the Deerfield Basin.

TABLE IV. — *Flow of Water at Various Points in the Deerfield Basin in Twenty-four Hours.*

	G.	H.	K.	A.
Drainage area in square miles above the point indicated,	660	499	317	230
Cubic feet . .	31,369,800	24,675,000	15,147,000	8,553,600
Gallons . .	234,646,000	184,569,000	113,299,600	63,980,900

TABLE V. — *Summary of Statistics.*

Drainage area in square miles	660
River-flow (dry weather) in 24 hours, cubic feet at G. .	31,369,800
River-flow (dry weather) in 24 hours, United States gall's,	234,646,000
Number of factories	24
" " per square mile	0.036
" of operatives in factories	1,294
Population of Massachusetts towns in 1865 . . .	18,364
" " " in 1875 . . .	18,055
" of all towns in 1870	25,597
" " " in 1880	23,951
" per square mile	36

TABLE VI. — *Examination of Water from the Deerfield Basin.*

[Results expressed in parts in 100,000.]

DATE OF ANALYSIS.	Locality on the Map.	Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Fixed Residue.	Volatile Residue.	Total Residue.	Hardness, English scale.
	No.							
Oct. 11 .	A.	0.0005	0.0142	0.12	1.70	2.70	4 40	$1\frac{1}{2}°$
Oct. 12 .	B.	0.0010	0.0034	0.20	1.90	6.10	8 00	$5\frac{1}{2}°$
Oct. 12 .	C.	0.0064	0.0210	0.14	5.10	6.10	11.20	$5\frac{1}{2}°$
Oct. 12 .	D.	0.0024	0.0078	0.24	1.30	7.50	8.80	$6\frac{1}{2}°$
Oct. 12 .	E.	0.0005	0.0090	0.36	1.30	16.90	18.20	$5\frac{1}{2}°$
Oct. 14 .	F.	0 0008	0.0074	0.16	3 30	9 10	12 40	$6\frac{1}{2}°$
Oct. 13 .	G.	0.0013	0.0043	0.10	6.65	9.30	15.95	3°

MILLER'S RIVER.

Miller's River takes its rise in the northern part of Worcester County, Mass., and in the southern part of Cheshire County, N.H. It flows, for the most part, in a westerly direction to the middle of Franklin County, Mass., where it joins the Connecticut River a few miles above Turner's Falls.

The head-waters are large ponds, mainly in the town of Ashburnham, Mass., and Rindge, N.H. Upper Nankeag and Little Nankeag Ponds, in the former town, are at an elevation of 1,150 feet above the sea-level, and have an area of 1,000 acres. These ponds seem to contribute a greater amount of water, taking the yearly flow, than Lake Monomonac, 2,600 acres in extent, which lies mostly in Rindge, N.H. In Winchendon, five miles from Ashburnham and three miles from Rindge, the head-waters from these two sources are united in a large natural reservoir, furnishing power to several large manufactories near the centre of the town.

Above this point, we find few factories along the river that cause any appreciable pollution of the water. In Ashburnham are a few wood-working shops, employing together not more than twenty men; and in Rindge, above Lake Monomonac, are four shops of similar character, having in all fifty operatives. A mile below the lake is a cotton-mill, running 7,300 spindles and 185 looms. It employs 175 persons, and uses 500 pounds of dyestuffs per day.

On that portion of the river flowing from Ashburnham, which is usually considered the main stream, there is a wool-scouring mill, at present running less than three months in the year. A very small quantity of chemicals is used here, amounting to not over fifteen pounds per day when the mill is running.

MILLERS RIVER.

Compiled from Walling's Maps.

Drainage Area, total,	410	Sq. Miles,
in Massachusetts	318	"
Woolen and Shoddy Mills, thus		■
Wool Scouring, "		○
Cotton Mills, "		●
Paper "		⊘
Tanneries, "		▲
Foundries, "		⊘
Machine Shops, "		✕
Sewing Machine Factory, "		⊟
Wood-Working Shops, "		✳
Gas Works,		&

Miles

Kilometres

Note.

The figures, thus 8/12, show the available fall at each dam. The letters are referred to in the tables of analyses and statistics.

N

Jaffrey.

Fitzwilliam.

Richmond.

Rindge.

NEW HAMPSHIRE.

LAKE MONOMONAC

A

North Branch Millers River.

Winchendon.

Warwick.

Royalston.

Priest's Brook.

Millers River.

Tully River.

Naukeag Lakes

Ashburnham.

B

South Royalston.

P

Millers River.

Otter River.

Baldwinville.

Otter River.

Connecticut River.

M

Erving.

Wendell Depot.

Orange.

R

Athol.

Millers River.

Tully River.

Millers Falls.

Millers River.

Eagleville.

Phillipston.

Templeton.

Otter River.

C

D

Gardner.

South Gardner.

H

Wendell.

W. A. FISH, PHOTO-LITH. BOSTON.

In the town of Winchendon are several manufactories directly on the river and draining into it. The machine-shop and foundery of B. D. Whitney give employment to 60 persons. Another shop just below employs 70 hands. A cotton-mill running 2,080 spindles and 70 looms has 50 operatives; and a tannery, turning out 40 hides per day, employs 14 men, and uses 1,000 cords of bark per year.

A little farther down the river, in a part of the town called Waterville, are several large wood-working manufactories, making great quantities of furniture, tubs, pails, and toys. Nearly 370 persons are employed in these establishments.

Some three miles farther down, near the southern boundary of Winchendon, a tributary called Priest's Brook flows into the river. This brook drains a portion of the towns of Jaffrey and Fitzwilliam in New Hampshire, but there are no factories in operation on this stream.

A half mile below the mouth of Priest's Brook, Otter River flows into Miller's River. This is a dark, sluggish stream, taking its rise in the town of Gardner. It flows northerly and westerly, through the villages of Otter River and Baldwinville, having insufficient force and volume to render it valuable for more than a limited number of manufacturing privileges. Ponds and reservoirs in South Gardner are the principal sources of this river, and these furnish power for several wood-working shops; but in Gardner Centre and West Gardner it has been found necessary to depend almost entirely upon steam in the large chair-factories which were erected upon tributaries to Otter River, in the expectation that water-power would be sufficient for the demands of their business. Nearly thirteen hundred persons are employed in factories draining into Otter River in the town of Gardner alone; and the yearly business of these establishments amounts to over one million five hundred thousand dollars, while the actual horse-power furnished by all the dams of the thirteen water-privileges is less than two hundred and fifty.

Leaving Gardner, and following the course of Otter River through cold, marshy lands, we come to the small railway-station of Templeton on the Fitchburg Railroad; but the village itself is called Otter River. Here are two shoddy-

mills and one woollen-mill, running respectively six, ten, and six sets of machinery, and employing two hundred and seventy persons. One mile below the shoddy and woollen-mills is a paper-mill in the village of Baldwinville, employing fifteen hands, and producing three tons of paper daily. Here the rags are simply sorted and cut, without washing, boiling, or bleaching.

From this point to the mouth of Otter River, there are six wood-working shops, employing altogether a hundred and eighty-five men.

Three miles below the junction of Otter and Miller Rivers is the town of South Royalston, which has a woollen-mill and chair-shop, employing in the former nearly a hundred hands, and in the latter twenty. The woollen-mill runs five sets of machinery, and produces one thousand yards of cloth per day. Nearly three hundred pounds of dyestuffs and detergent chemicals are used in the process of manufacture.

Through the centre of Royalston the Tully River flows southerly and westerly, draining a considerable territory, including the towns of Fitzwilliam and Richmond in New Hampshire, the greater part of Royalston, North Orange, and a portion of Warwick. This river joins Miller's River just north of the thickly populated part of Athol. It has one woollen-mill three miles above its mouth, running two sets of machinery, and employing thirteen hands.

Six miles below South Royalston is the town of Athol, situated directly on Miller's River. This town has four thousand inhabitants, and a large number of manufactories. There are two woollen-mills, making satinets and blankets, three cotton-mills, two large shoe-factories, a wool-scouring mill, a dyehouse, several machine-shops, and numerous wood-working establishments, manufacturing furniture, boxes, match-splints, etc. The Athol Gas-Company's works are also on the river.

In the middle of the town is a shallow pond, receiving a considerable amount of drainage from factories, shops, and residences near by. The bottom and sides of this pond have become foul and covered with filth and slime. When the water is low, considerable annoyance is caused by bad smells arising from the decomposition of the filth exposed to the sun.

Athol has a good water-supply from springs in Phillipston, but no attempt is made to provide proper drainage. A system of sewers is greatly needed.

A few miles below Athol is a tributary to the river, flowing northerly from large ponds which furnish power for three shoddy-mills, employing together about sixty hands, and running in all only five sets of machinery.

Following the course of Miller's River a few miles farther west, we come to the town of Orange, which has a population of over three thousand. The most important industry here is the manufacture of sewing-machines, in which over four hundred hands are employed; and in other machine-shops and founderies are two hundred and twenty-five workmen. Two furniture-factories, also on the river, have seventy-five hands.

The region directly north of Orange, comprising the town limits of Warwick, is drained by tributaries to Miller's River. There are few inhabitants and no manufactories in this district.

Next west of Orange is Wendell Depot, a village of perhaps a hundred inhabitants, having one factory only, a wood-pulp paper-mill, employing ten hands, and consuming two cords of wood per day. No chemicals are used in this process. The pulp is produced and sold in the form of thin sheets, to be used in other mills where the paper is finished.

In Erving, two miles west of Wendell Depot, there are three wood-working shops, manufacturing piano-cases, furniture, etc., and giving employment to one hundred and fifty persons.

From this point to Miller's Falls, six miles distant, we find a thinly-settled agricultural district with no manufactures. At Miller's Falls is a large establishment, employing one hundred and twenty-five hands in making tools, machinery, and hardware. A small musical-instrument manufactory has also just been established, which has thirty persons employed.

With the exception of a small wood-working shop close by, having a dozen hands, there are no other manufactories draining into Miller's River, which, from this point, rushes along a rocky bed in a rapid descent to the Connecticut.

The territory drained by Miller's River is thinly settled,

and for the most part hilly. The soil in the eastern portion of the basin is in many places wet, cold, and swampy; but from Athol to the Connecticut Valley the surface of the country is undulating, with steep rocky hills, and much unproductive sandy soil in the more level portions. Pure spring-water is almost everywhere abundant, and the natural drainage is good.

Almost from its source to the mouth, the water of Miller's River is reddish and dark; probably colored by peat-bogs and ochre-beds through which it passes. From the head-waters to South Royalston, the descent of the stream is gradual; and there are few places where a considerable velocity of current is observed in summer. From South Royalston to Athol, a few narrow, rocky descents give impetus to the current for short distances. From Athol to Erving the fall is slight, and the current is correspondingly slow; but from Erving to the mouth of the river the descent is frequently abrupt, and the stream is rapid.

In the factories along the whole course of Miller's River, no attempt seems to be made to utilize or keep out of the water the excrement of the operatives. The privies are almost invariably placed directly over the stream.

In the vicinity of Gardner, Athol, and Orange, there is complaint of some contamination of the water by the factories and town drainage; but elsewhere there is at present no real difficulty from that cause.

Water-Supply and Sewerage.

Athol and the village of Miller's Falls are the only places in Miller's River Basin having a public water-supply.

For Athol the water is obtained from springs in Phillipston. It is abundant and pure, and there is little danger of contamination. The principal distributing reservoir, twenty acres in extent, is situated at a level of over two hundred feet above the town. From eight to ten miles of pipes have been laid already. There is, however, no system of sewerage in the town, and the need is pressing for immediate action in this respect.

Miller's Falls has a partial supply of water from springs on the neighboring hillsides; and enough can easily be obtained in this way to supply the whole village, even with a large increase of population. There are no sewers here at present.

Gardner, with its five thousand inhabitants and numerous factories, depends entirely upon wells and cisterns for drinking-water. Many of these wells are exposed to serious danger of contamination from various polluting agencies. When the water in some of the wells is low, it becomes offensive to smell as well as taste.

Several plans for a water-supply have been proposed, and considered by the towns-people. The one now most in favor contemplates taking water from a pond close to the thickly settled part of the town. There is a large cemetery, well filled with graves, draining directly into the pond opposite the proposed location for the pumping-engines. At present the indications are that this project will be adopted.

Complaint is made by some mill-owners in Gardner, that the drainage from privies in the mills farther up the stream pollutes the water below.

TABLE VII. — *Population of Towns in Miller's River Basin.*

MASSACHUSETTS TOWNS.	Population. 1865.	Population. 1875.	Population by U.S. Census, 1880.
Ashburnham	2,153	2,141	1,666
Athol	2,814	4,134	4,307
Erving	576	794	872
Gardner	2,553	3,730	4,998
Orange	1,909	2,497	3,171
Phillipston	725	666	621
Royalston	1,441	1,260	1,192
Templeton	2,390	2,764	2,789
Warwick	901	744	713
Wendell	603	503	465
Winchendon	2,801	3,762	3,722
Total	18,866	22,995	24,516

NEW HAMPSHIRE TOWNS.		Population by U.S. Census, 1870.	
Fitzwilliam	–	1,140	1,187
Rindge	–	1,107	936
Richmond	–	868	669
Total	–	3,115	2,792

TABLE VIII. — *Polluting Factories in Miller's River Basin.*

Name of River or Stream.	Description of Mill.	Location.	Head and Fall, in ft.	Number of hands employed.	Quantity of Materials used per day.
North Branch	Cotton-mill	Winchendon	22	175	4,200 pounds cotton, 75 pounds indigo, 50 pounds potash, 400 pounds cutch, 250 pounds starch.
Miller's River	Wool-scouring	"	12	5	8 pounds soda-ash, 6 pounds saponine.
" "	Cotton-mill	"	19	50	100 pounds cotton, 60 pounds starch.
" "	Machine-shop and foundery	"	19	60	12 pounds sulphuric acid.
" "	Machine-shop	"	14½	70	2½ pounds sulphuric acid.
" "	Tannery	"	10	14	100 pounds lime, ½ bushel hen-manure, 3½ cords bark.
Otter River	Shoddy-mill	Otter River	16½	115	1,950 pounds rags, 1,050 pounds cotton, 78 quarts oil.
" "	Shoddy-mill	"	14	75	1,300 pounds rags, 700 pounds cotton, 52 quarts oil.
" "	Woollen-mill	"	16	80	475 pounds wool, 125 pounds cotton, 19 quarts oil, 25 pounds soda-ash, 60 pounds logwood, ½ pound sulphuric acid.
" "	Foundery and machine-shop,	"	8	30	1 ton iron, ½ ton coal.
" "	Paper-mill	Baldwinville	16	15	6,000 pounds rags, 2,000 pounds paper and dustings, 1½ tons coal.
Miller's River	Woollen-mill	South Royalston,	12	85	1,500 pounds wool, 240 pounds logwood, 20 pounds soda-ash, 20 pounds sal-soda, 3 pounds chrome, 3 pounds sulphuric acid, 2 pounds blue vitriol, 45 quarts oil, 3 gallons urine.
Tully River	Shoddy-mill	Athol	18	13	750 pounds shoddy and cotton, 45 quarts oil.
Miller's River	Shoddy-mill	"	16	40	2,500 pounds cotton and rags, 25 quarts oil.
" "	Cotton-mill	"	14½	80	1,700 pounds cotton, 25 pounds starch.
Trout Brook	Cotton-batting	"	16	6	500 pounds cotton.
New Channel Miller's River,	Cotton-batting	"	8	4	1,000 pounds cotton.
" "	Shoddy-mill	"	8	12	375 pounds shoddy and cotton, 4 quarts oil.

" " .	Machine-shop .	" . .	7	25	825 pounds iron.
" " .	" .	" . .	16	4	Superintendent unable to estimate quantity of material used.
" " .	" .	" . .	8	2	" " " " " "
" " .	" .	" . .	Current wheel.	17	" " " " " "
" " .	" .	" . .	14½	5	" " " " " "
" " .	Shoe-factory .	" . .	Steam.	200	" " " " " "
" " .	Shoe-factory .	" . .	"	40	" " " " " "
" " .	Dye-house .	" . .	"	1	2 pounds logwood, 2 pounds hypanic, fustic, chrome, sumac, copperas.
" " .	Wool-washing .	" . .	8	3	10 pounds soda-ash.
" " .	Iron-foundery .	" . .	9	25	1,100 pounds pig-iron.
" " .	Gas-works .	" . .	-	2	⅔ ton coal, 1⅓ bushels lime, 6 barrels water.
" " .	Blanket-shop .	" . .	8	15	1,600 yards cloth, 15 pounds starch, 1 pound aniline dye.
Eagleville Brook,	Shoddy-mill .	Eagleville . .	8½	20	750 pounds shoddy and cotton, 8 quarts oil.
" "	" .	" . .	12	15	500 pounds rags and cotton, 3 gallons oil.
" "	" .	" . .	14	20	1,000 pounds rags and cotton, 10 quarts oil.
Miller's River .	Sewing-machine factory . .	Orange . .	8	400	5½ tons cast-iron, 400 pounds malleable iron, 240 pounds steel, 1 ton coal.
" " .	Iron-foundery .	" . .	8	125	12 tons pig-iron, 240 pounds sulphuric acid, 2⅔ tons coal.
" " .	Machine-shop .	" . .	8	20	930 pounds cast iron, 130 pounds wrought-iron.
" " .	Machine-shop .	" . .	3½	80	2 tons iron.
" " .	Paper-pulp mill,	Wendell Depot .	13	10	2 cords wood.
" " .	Tools and hard-ware manuf. .	Miller's Falls .	13	125	2 tons iron, 50 pounds steel, 65 pounds pig-iron, 35 pounds pig-lead, 20 pounds antimony, 25 pounds muriatic acid, 1 pound sulphuric acid.
" " .	Musical-instrument manuf. .	" .	12	30	20 pounds sheet-brass, 20 pounds zinc, 12 pounds sulphuric acid.

TABLE IX. — *Summary of Manufactures.*

	Number.	Operatives Employed.
Cotton-mills	5	315
Woollen-mills	2	165
Shoddy-mills	8	310
Wool-scouring mills	2	8
Paper-mills	2	25
Tanneries	1	14
Machine-shops and founderies	14	618
Sewing-machine factories	1	400
Gas-works	1	2
Shoe-factories	2	240
Dye-houses	1	1
Blanket-shops	1	15
Total	40	2,113

The river was gauged at various points indicated on the map, and the flow of water determined as closely as possible during the latter part of the extremely dry summer of 1880. Very little rain fell throughout this summer and the spring preceding. The river was everywhere low during the months of July, August, and September; and, at the time the measurements were made, manufacturers reported much less water in the river than they had ever known before. The quantities given in the table may therefore be taken as representing quite closely the dry-weather flow of the stream.

Any thing like absolute accuracy in the determination of the flow of the stream is of course impossible; since there is a considerable variation in the velocity and volume of water even within a few hours time, resulting from the very irregular use of the water by the many manufacturers along the river. This causes a want of uniformity in the results obtained which it is impossible to avoid.

TABLE X. — *Flow of Water at Various Points in Miller's River Basin in Twenty-four Hours.*

	M.	R.	P.	N.
Drainage area in square miles above the point indicated,	410.	340.	186.	92.
Cubic feet	22,680,000	19,387,000	10,810,000	5,115,800
Gallons	169,646,400	145,014,800	80,858,800	38,266,000

TABLE XI. — *Summary of Statistics.*

Drainage area in square miles	410
River-flow (dry weather) in 24 hours, cubic feet at M.	22,680,000
River-flow (dry weather) in 24 hours, U.S. gallons at M.	169,646,400
Number of factories	40
Number of factories per square mile	0.098
Number of operatives in the factories	2,113
Population of Massachusetts towns in 1865	18,866
Population of Massachusetts towns in 1875	22,995
Population of all towns in 1870	24,362
Population of all towns in 1880	27,308
Population per square mile	66.5

TABLE XII. — *Examination of Water from Miller's River Basin.*

[Results expressed in parts in 100,000.]

DATE OF ANALYSIS.	Locality on the Map.	Free Ammonia.	Albuminoid Ammonia.	Chlorine.	RESIDUE.			Hardness.
					Fixed.	Volatile.	Total.	
Oct. 16	A.	0.0043	0.0192	0.12	1.00	2.50	3.50	$\frac{1}{2}$°
16	B.	0.0043	0.0110	0.10	2.40	2.00	4.40	$\frac{1}{2}$°
15	C.	0.0011	0.0130	0.20	1.60	1.00	2.60	$\frac{1}{2}$°
15	D.	0.0035	0.0114	0.18	4.80	4.30	9.10	1°
15	E.	0.0011	0.0004	1.40	4.70	6.80	11.50	4°
15	F.	0.0008	0.0014	2.10	13.30	4.70	18.00	7°
15	G.	0.0245	0.0148	0.44	1.10	6.80	7.90	1$\frac{1}{2}$°
15	H.	0.0008	0.0014	0.40	1.40	2.30	3.70	1°
15	K.	0.0011	0.0150	0.24	1.60	3.70	5.30	1°
15	L.	0.0037	0.0210	0.14	0.80	5.40	6.20	1°
13	M.	0.0009	0.0123	0.47	5.10	13.95	19.05	1°

The waters marked C, D, E, F, G, and H, in the above table, are all from the town of Gardner. C and D are from Crystal Lake, the proposed source of public water supply for the town. C was taken from a point on the eastern shore of the lake to the north of the proposed pumping-station, and D from the lower part of the lake near the railroad-crossing. E and F represent wells in common use, but regarded with some suspicion by reason of illness among those using the water from them. G is from one of the lower mill-ponds, which drains into Otter River: this pond is not used as a source of water for domestic use, and the analysis is only given in order to show the pollution of a limited water-supply when used for manufacturing purposes. H is from the well of a schoolhouse in South Gardner. A few cases of diphtheria among the scholars had drawn public attention to the well-water. So far as a chemical analysis goes, the cause of the disease did not lie in any pollution of the well.

THE SEPARATE SYSTEM OF SEWERAGE.

BY

ELIOT C. CLARKE, C.E.

PRINCIPAL ASSISTANT ENGINEER IN CHARGE OF IMPROVED SEWERAGE, BOSTON, MASS.

THE SEPARATE SYSTEM OF SEWERAGE.

THERE has never been any generally accepted rule for determining the proper sizes of sewers. In this respect, even since sewerage has been studied as a science, engineering practice has usually been divided into two schools, one teaching that all sewers should be large enough for men to enter, and that, the larger they are, the better they fulfil their purpose, both in removing excessive rains and in affording convenient facilities for repairing and cleaning them; the other contending that smaller sewers are generally more efficient, that it is unwise to proportion them with reference to exceptional storms, and that equally good results, at less expenditure, may be obtained by building a large portion of any sewerage system of small earthenware pipes.

Of late years these varying ideas have become somewhat reconciled; and, while considerable diversity still exists in the practice of individuals, most engineers would assent to the statement, that, although it is better to have all sewers large enough to enter, yet the advantage does not compensate for the increased cost; that pipe-sewers may properly be used for a portion of most sewer systems, and that it is only necessary to proportion sewers for carrying off rain-storms of from one-half an inch to one inch an hour, depending on the nature of the district sewered. Until recently few persons have questioned the expediency of removing both the sewage and the surplus rain-water by means of one and the same set of sewers.

More than thirty years ago, however, it was suggested in England that it would be better to build a separate set of sewers, adapted solely to the removal of the sewage proper, or contaminated water supply, without regard to the rain;

the latter being either carried in a second and distinct system of underground conduits, or allowed to flow off over the surface of the ground. The plan found little favor among engineers, and was not applied to any large town until about four years ago, when it was partially adopted in remodelling the sewerage system of Oxford, which has a population of over twenty thousand. The sewers built at this place are much smaller than is customary, and receive no rain, except along the upper portion of their branches, where a little is admitted for purposes of flushing. Within the last two years the advantage of keeping separate the sewage and the rain has been strongly urged by a few American engineers; and last year it was adopted in its strict integrity in constructing a system of sewerage for Memphis, a city of forty thousand inhabitants.

The system is usually called "The Separate System," and the purpose of this paper is to examine its merits.

If the system had been fully tried, under various conditions, for a reasonable time, and the results observed, there would be no use in discussing it; for a few examples of success or failure would outweigh a multitude of arguments *pro* or *con* concerning it. But since it is believed that there has been no sufficient trial to warrant a final decision as to its merits, and as it will doubtless be brought to the notice of any city or town of the Commonwealth which may contemplate the adoption or alteration of a sewerage system, it may be useful to offer, for the consideration of those interested, a study of the probabilities, in the light of present experience.

The statements usually made in support of the separate system are these: —

1. The primary object of sewerage — the all-important and only essential requirement of it — is the removal of sewage proper, that is, of water holding in solution or suspension waste organic matters liable to decompose and become noxious. All other functions are comparatively unimportant and secondary, and should not be permitted to lessen its adaptability to the essential purpose.

2. The amount of the polluted water supply from any district is so insignificant in proportion to the quantity of rain-water falling on it during rain-storms, that sewers designed for receiving storm waters are thereby impaired as to their

efficiency for conveying sewage; because, being much larger than would otherwise be necessary, the depth and velocity of the ordinary flow is less.

3. The small sewers of the separate system are more easily cleansed by flushing.

4. Large sewers generate and contain a greater quantity of noxious gas than small ones, and are not so easily ventilated.

5. So much smaller sewers will suffice to carry off the sewage only, that their cost need be but a fraction of what would be required to build sewers admitting rain; and by adopting the former many towns can avail themselves of the benefits of sewerage which would otherwise be debarred from it on account of the expense; and in any case the difference in cost will be considerable.

6. Rain-water in excess is seldom worse than inconvenient, and, at most places, can properly be allowed to flow off over the surface of the ground, as it does everywhere before the introduction of sewerage.

7. Where it is absolutely necessary to remove the rain as well as the sewage by means of underground conduits, two sets of sewers can be built, each designed for its special purpose; and the greater efficiency of both will compensate for the slight increase in cost.

8. Where the sewage must be raised by pumping, or treated in any way, these operations can only be satisfactorily accomplished if the sewage is unmixed with rain.

These statements, together with their truth and weight, will be considered in order.

1. It is true that an essential, sometimes the only essential, requirement of sewerage, is the removal of water containing noxious matters, or matters which may become noxious; but it is also true that sometimes the removal of surface and soil water is, if not an equally essential, still an essential requirement, and, both for sanitary and economic reasons, is usually an important function of a sewerage system. So true is this, that the latter was considered the chief requirement of sewerage, for centuries before the danger from filth and filth-diseases was recognized. "Main drains and common shores" (sewers) were laid under town streets in Massachusetts before the year 1700; and for one hundred and thirty years thereafter the chief purpose in building them was the re-

moval of surplus rain and the lowering of ground-water. They are mentioned in ordinances of the period as being "for the draining of cellars or lands." Excrementitious matters were by law excluded from these sewers, the leakage, even, from vaults not being admitted, at Boston, before 1833; and other solids were kept out by the placing of strainers on connecting drains. It is customary, at most places, to extend sewers into thinly settled regions, which furnish little or no sewage, in order to expedite the removal of rain and soil waters. The danger from a damp soil and subsoil is not less real, though possibly less in degree and less easily traced to its source, than that from the proximity of sewage.

Moreover, the noxious matters which are removed by the sewers for sewage only, of the separate system, are not the only ones which occur in the vicinity of a dense population. It is a common mistake to regard fæcal matters as the only foul element in the composition of sewage. That they are not even the preponderating source of such impurity, is shown by the fact that chemical analysis has failed to detect any marked difference between the sewage from towns having water-closets and those where such matters are not allowed to enter the sewers. If the water used for household purposes, such as bathing, washing of clothing, utensils, etc., may properly be termed sewage, it is obvious that the rain which washes streets and sidewalks, houses and yards, is equally so, especially when it is remembered that sweepings from city streets are sometimes sold to be used for manure. In a city the first rain which falls washes the surface of the ground and becomes very foul, afterwards it flows off comparatively clean; certainly this first portion of rain, loaded as it is with impurities, the droppings of animals and much other organic refuse, is as obnoxious as an equal amount of ordinary sewage, and equal care should be taken to get rid of it.

The first proposition is therefore only partially true. It is important as a sanitary measure to remove promptly the sewage proper: it may also be important to remove the rain, especially the early part of it. But there can be little question, that, if building sewers to answer this double purpose impairs appreciably their efficiency in removing the sewage, this fact furnishes a reason for avoiding such practice, and disposing of the rain by other methods.

2. Do sewers designed for rain convey the ordinary sewage less efficiently? At first sight it would certainly seem as though they must; for the amount of daily sewage contributed by a district is so insignificant as compared with the amount of rain-water flowing from it in time of rain, that it seems impossible that a single structure should be suitable for removing both quantities. The diversity may be illustrated by an example.

If the use of water were uniform throughout the twenty-four hours, a town of five hundred acres with a population of ten thousand persons and a daily water supply of sixty-five gallons per head, would discharge into the sewers exactly one cubic foot of water during each second of time. But since more water is used at some hours that at others, it is possible that twice the average, or two cubic feet a second, might at times be discharged, and during certain hours of the night, as little as one-half the average, or one half of a cubic foot a second; although, owing to defective plumbing, leakage, and waste, such extreme variations are seldom noticed. Now, a rainfall of an inch an hour on the same area would yield two hundred and fifty cubic feet of water a second.

The *main* sewer for the assumed district must therefore, under either system, be able to discharge both two cubic feet a second, and one-half of a cubic foot a second, and in the combined system admitting rain must also be able to discharge two hundred and fifty cubic feet a second. Assuming, again, that the rather favorable inclination of one foot in five hundred can be obtained, it appears that, with the proposed conditions, under the separate system, a pipe fifteen inches in diameter will answer all requirements; and under the combined system a brick sewer, six and one-half feet in diameter, will be needed.

The appearance of these main sewers while fulfilling their functions is represented in the sketch on the following page.

It will be noticed, that, with the ordinary flow of sewage, the small sewer has an advantage in respect to depth and velocity of flow; but the difference is much less marked than is commonly supposed.

This of course is but a single case, and presents the advantage of the separate system, as regards velocity, in its strongest light. In not one per cent of the sewers of the two sys-

tems would such diversity of size exist. The smallest sewers of the separate system at Oxford are nine inches in diameter, at Memphis they are but six inches; thirty-six per cent of

6.5 Feet Circular Sewer Showing

250 cubic feet discharge velocity 8 feet per second.
2 " " " 2 " "
½ " " " 1¼ " "
Inclination, 1–500.

15-inch Pipe Showing

2 cubic feet discharge,
Velocity 2.5 feet per second,
and
½ cubic foot discharge,
Velocity 1⅔ feet per second.

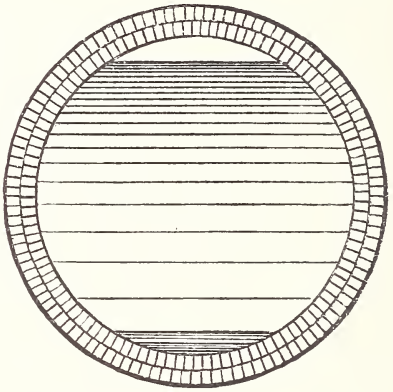


Fig. 1.

the sewers at Chicago, which admit rain, are but twelve inches, and seventy per cent not over two feet in diameter: at Brooklyn over eighty per cent are said to consist of pipes.

Branch Sewers.

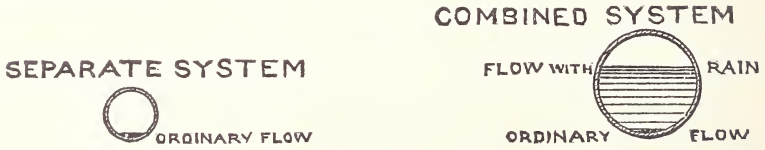


Fig. 2.

The *branch* sewers (the greater portion of each system), comparing those of Memphis and Chicago, may be shown by Fig. 2.

It will be noticed that the difference in size is not nearly so marked as before, and neither of these will have more than

a trickling stream running through it. Nor will either have any appreciable advantage in respect to depth or velocity of flow. It is true as regards circular sewers, that, however trifling the difference in velocity and depth of flow of the ordinary run of sewage may be, still the advantage is always on the side of the smaller sewers of the separate system. But this is not necessary: there need be no difference whatever; for it is possible to shape the bottoms of the large brick sewers of the combined system to correspond exactly with those of the small pipe sewers of the separate system, in which case the depths and velocities in both will be precisely the same. The way in which this is or might be done is shown in Fig. 3.

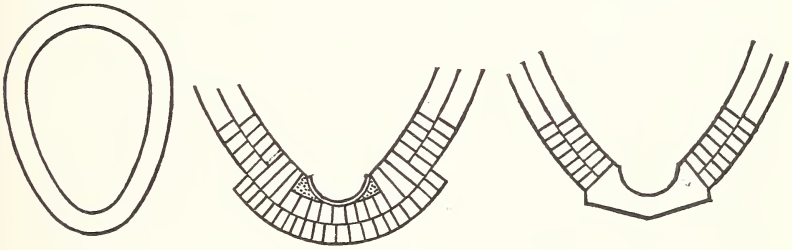


Fig. 3.

Such shapes are sometimes built; and the reason they are not oftener used is, that the advantage is thought not to compensate for the slight additional expense. With any practicable inclinations the upper portions certainly of the sewers of either the separate or combined system will not always be kept clean by the ordinary flow of sewage. The best authorities agree that a velocity, maintained continuously, of about three feet a second,[1] is necessary to surely prevent the beginning of deposits. In order that floating bodies may not strand, the centre depth should probably be at least three inches. In the following table[2] are given the incli-

[1] Most writers prescribe a greater velocity for small sewers than for large ones; perhaps because the large sewers are of brick instead of glazed pipe, and the slight roughness of their bottoms produces a constant disturbance of the lower layer of water, which tends to agitate and move deposits. It has been observed that sand, after moving over a brick bottom, has settled on a smoothly cemented one of equal slope.

[2] By formula $v = c\sqrt{rs}$ with Kutter's co-efficients. In calculating c, N (the co-efficient for roughness) is taken as 0.011 for pipes, and 0.013 for brickwork. Where s is a factor of c, it is assumed to be 0.01.

nations, and gallons of sewage per minute, requisite to enable different-sized circular sewers, as usually constructed, to fulfil these two conditions.

Size of Sewer.	Inclination.	Gallons of Sewage per minute.
6-inch pipe	1 in 111	132
9-inch pipe	1 in 133	174
12-inch pipe	1 in 145	207
2-feet brick	1 in 101	306
4-feet brick	1 in 108	441
6-feet brick	1 in 109	544

It will be seen, that, with any size of sewer, the needed inclination to produce a three-feet velocity with three-inch depth is rarely obtainable, representing as it does in the most favorable case a rise of thirty-six feet in one mile. And, to maintain even this slight depth, the least amount of water needed, which would be for the six-inch pipe, represents the drainage from fully three hundred houses, a greater number than are ever tributary to a branch sewer. With the ordinary flow of sewage, deposits will be apt to occur in the sewers, especially the branch sewers, of either system; but in those of a combined system these deposits, unless of an exceptional nature, will be swept away by the currents occasioned by every rain-storm.

For, if a velocity of three feet a second will prevent the beginning of deposits, it will also stir up and carry along deposits already formed. Now, although it appears from the previous table, that to maintain a velocity of three feet a second in a six-foot sewer, running three inches deep, requires an inclination of 1 in 109, yet, by referring to the one below which gives inclinations needed by the same sewers to maintain this velocity when running half full with rain, it is seen that the slope need be but 1 in 2,500.

Size of Sewer.	Inclination.	Size of Sewer.	Inclination.
6 inches	1 in 111	2 feet	1 in 568
9 inches	1 in 198	4 feet	1 in 1,471
12 inches	1 in 308	6 feet	1 in 2,500

It will be noticed, that, while the small sewers are not much less steep than before, the large ones, on inclinations that are generally obtainable, afford this required velocity.

This thorough cleansing of a combined system by rain constitutes its great merit; and the lack of it is a disadvantage in a separate system. Neither system can be called self-cleansing by the action of the sewage alone, nor is that merit claimed for the separate system; and in a combined one, although most of its sewers will be cleansed by every storm, yet deposits may be left in the extreme upper portions which receive but little rain, and those accumulating elsewhere during the intervals between storms may have time to decompose and become harmful.

It is possible that some zealous advocates of the combined system might deny that appreciable danger arises from deposits of sewage sludge, provided they are swept away before accumulating in sufficient bulk to cause obstructions. It might be said that sewers with fair inclinations are generally found to be without deposits, or with only slight ones, and that even in the latter case, if ventilated at the man-holes, they are not dangerous, and hardly offensive to one walking through them; that analyses of the atmosphere of even so dirty a sewer as that in Berkeley Street, Boston, failed to detect a degree of pollution which could be called dangerous; that the cases of filth-disease noted in a community do not occur in neighboring houses connected with the same defective sewer, as would happen were the sewer the cause, but are widely scattered, and are always traceable to something wrong in the drainage of the individual houses; that at country houses with well-arranged house-drains, no danger is ever anticipated from the universal practice of connecting these drains with cesspools, although cesspools are always fouler than any city sewer.

These arguments have considerable force; and the answer to them is, that, however slight the risk from deposits in sewers may be, still, as it is a risk affecting health and even life, it is not right to impose it upon a community if it can be avoided.

Acting on this idea, at Memphis the sewers are flushed, not merely often enough to prevent them from becoming entirely obstructed, but every day in order to sweep away deposits

before they begin to decompose. This is a great improvement on ordinary practice, and, as it is equally adapted to large as to small sewers, may wisely be adopted for sewerage systems constructed on the combined system.

We reach, therefore, the third consideration, — the relative facility with which the sewers of either system can be artificially cleansed.

3. The substances which lodge in sewers, and obstruct them, are: grease from kitchens; pieces of cloth, wood, metal, and crockery; ashes and other household refuse, carelessly thrown into house-drains; some kinds of manufacturing refuse, and fine sand which works its way through joints; and, in sewers connected with the streets, road detritus, gravel, leaves, twigs of trees, etc. The cheapest and most convenient way of removing most of such accumulations is by flushing; that is, sending a large quantity of water through the sewers with sufficient force to sweep away any obstacles.

As has been said, it is the upper portions of sewers that most frequently need cleansing: the proper place to apply the flush for cleaning these upper portions, is at their highest points, at the ends of the branch sewers. Tanks should be built at such points, and the requisite amount of water emptied into the sewers as often as is necessary. At Memphis these tanks hold about one hundred gallons each, and are emptied once or twice every twenty-four hours, filling the six inch sewers about three inches deep, or half full. By referring to p. 32, it will be seen from the table, that, where the inclination of these six-inch pipes is as great as one in one hundred and eleven, the resulting velocity will be three feet a second, that is, sufficient to move ordinary deposits. If, instead of these six-inch sewers, larger ones for rain had been built, on the same inclinations and with their bottoms shaped like those of the six-inch pipes, the same quantity of water, applied in the same manner, would have produced a precisely similar effect. In fact, however, the branch sewers of a combined system almost always consist of twelve-inch pipes. By again referring to the table (p. 32) it appears that to produce, in a twelve-inch pipe, a three-foot velocity, three inches deep, lasting one minute, requires two hundred and seven gallons of water, instead of one hundred and thirty-two gallons as in the six-inch pipe, but that the inclination may be somewhat flatter for the former size.

In branch sewers with inclinations little less than one in one hundred, there is, therefore, no especial advantage, in respect to flushing, in either system more than in the other. But such steep inclinations are rarely practicable; and the twelve-inch pipes possess the great advantage over the six-inch ones, that by increasing the quantity of water used, until they are made to flow half full, a flushing velocity may be secured with slopes about one-third as steep as those required for the smaller pipes. Four times as much water will be needed in such cases, or, for one minute's flushing, over five hundred gallons, the value of which might be about five cents. In cases where economy in the use of pure water was necessary, it might be possible, by the adoption of a tipping-tank or some similar device, to use for flushing the waste water from one or more houses near the head of the branch sewer. A single house would ordinarily furnish as much as five hundred gallons a day for this purpose; but when there was no neighboring house, or when such house was unoccupied, other sources of supply would be needed.

As main sewers often must be built with but slight inclinations, they also may need flushing. The usual way to do this is to place at intervals in the sewers dams or gates, which, as desired, are closed until the sewage has accumulated behind them to a depth nearly equal to the height of the sewer. It cannot safely be made to rise much higher by putting the sewer under pressure, because in that case the sewage may be forced through house-drains into neighboring cellars. When sufficient sewage has accumulated, the gate is quickly opened, and the water rushes down, carrying every thing with it. This method is often necessary for sewers with very little inclination; and if they are several feet in diameter is very efficacious, as the effect of such a flush extends far down the sewer.

With such small sewers as are used in the separate system this method will be much less certain to produce the desired result, and will act for a much shorter distance. We have seen that a velocity of three feet a second moves ordinary deposits, and will in most cases, if maintained for a long enough time, be sufficient to clean a sewer; but as there are substances, such as very fine sand, bits of meat, skin, and other greasy or sticky matters which are not so easily dis-

lodged, this would hardly be called a strong flushing velocity, and one of five or six feet a second may sometimes be needed. Now, as velocity of flow in a sewer occurs solely through gravitation, that is, the falling of the sewage from a higher level to a lower one, the greater the distance which it can fall, the swifter the velocity it acquires. This velocity caused by gravitation is opposed and retarded by the friction between the surface of the sewer and the water passing through it. The less, therefore, the area of that surface in proportion to the amount of water flowing past it, the less quickly will the velocity be retarded. Now, in both these points large sewers have a great advantage over small ones. As an example let us compare a four-foot sewer with a twelve-inch one. After placing a dam in either sewer, on removing it the sewage accumulated in the larger sewer falls four times as far, and is opposed by only one-fourth as much surface in proportion to the amount of falling water, as in the smaller one. Neither the main nor the branch sewers, therefore, of a separate system, can be as effectively flushed as the larger ones of a combined system.

Some use has been made of an instrument called a "pill," as a means for cleansing sewers. As its name implies, it consists of a ball, hollow and somewhat smaller than the sewer to be operated on. The pill is introduced at a manhole, and is carried down the sewer by the current. As it obstructs the water-way, the sewage accumulates in a head behind it, and, spurting below and around it, stirs up and moves forward any deposits. This method is said to have worked well, both in large siphons and in pipe sewers, but it has hardly been in use long enough to afford definite conclusions as to its general applicability and effectiveness. It is equally adapted to the sewers of either system.

Although by flushing, ordinary deposits can be swept away, occasionally there are obstructions which must be removed by hand. It is astonishing to see what things get into sewers. Pieces of wood that pass endwise through a small house-drain sometimes lodge across a larger sewer. Cloth will catch on projecting pieces of cement, and form a nucleus about which deposits accumulate. Grease adhering to the sides, and increasing in concentric layers, may finally choke even a two-foot sewer. This grease can and should be in-

tercepted near the house, by means of properly trapped cesspools; but it often is not so stopped, and, if the house-drain has a good fall, may run in a liquid state a hundred feet or more, and congeal only on reaching the sewer.

If the sewers are large enough to enter, that is, over two feet in diameter, there is little difficulty in removing obstructions; if smaller, the work must be done by means of rods and chains, pushed or drawn from one manhole to another, at an expense many times greater than that of flushing. In either case the work will be more easily accomplished in the larger sewers of the combined system.

4. Not much is known of the noxious gases and vapors contained in sewers, or how they are generated. They probably arise from any putrefying deposits and from the decomposition of a slime usually noticed upon the interior surface. The area of this surface is greater in a large sewer, therefore the quantity of gas generated is greater. But, on the other hand, the cubical contents of the large sewer is also so much greater that there is more air to dilute the gas. For every square inch of surface of a six-inch sewer there is but one and a half cubic inches of air; in a twelve-inch sewer there are three cubic inches, and in a six-feet one eighteen inches. From this it would be expected, that, with any circulation of air in a sewer system, the air should approximate more nearly to its normal condition in the larger sewers; and such seems to be the fact. Large sewers can usually be entered without discomfort, smaller ones are apt to be more unpleasant, and small house-pipes are almost always offensive. In respect to its effect upon houses, the quantity of gas in a sewer is of no consequence: it is the degree of concentration which is important. As usually built, large sewers seem to have an advantage in this respect, over smaller ones.

There are practical difficulties in the way of thoroughly ventilating sewers. It is possible that small sewers may be more easily ventilated than large ones, but there has been little experiment to verify theories on this point. With all house-drains untrapped and open above the roofs of houses, it would probably be easy to ventilate sewers of any size, since the combined area of the drains would be many times that of the sewer. But such is not usually considered good practice. It is better to trap the drain, with an inlet above

the trap by which fresh air can pass through the house-pipes to the roof of the house. It is much more important to ventilate house-pipes than sewers; and with a trap between the two, and the former ventilated, any difference there might be in the degree of purity of air in the street-sewer, under the two systems, would be of little consequence.

5. The economy of building a separate system of sewers for any town depends, of course, upon whether or not a second set of sewers is also constructed for the rain. But the first cost of a system built for the sewage alone will be much less than that of one admitting rain. Sewers of the same size vary greatly in cost, and no fixed table of prices can be given for them, because the expense depends largely upon the nature of the ground excavated, rate of wages for labor, etc. But a good basis for comparison may be gained by ascertaining the average cost of a very large amount of sewer work constructed during a long series of years.

Chicago probably affords a better field for this study than any other American city. The whole sewerage system at that place was designed on one comprehensive plan, which has been adhered to from the beginning of the work in 1855. Over three hundred miles of sewers are already constructed. As the surface of the ground is very flat, so that but slight inclinations could be obtained, the sewers are larger than would otherwise be needed, a smaller proportion of them consists of pipes, and the cost is thereby increased. This, however, is compensated for by the fact that the excavation is somewhat less deep than is usual, and its character on the whole good. The catch-basins are about three hundred feet apart, on both sides of the street, and the man-holes are at intervals of about one hundred and twenty-five feet. The average cost, from 1855 to 1879, for the whole system, including catch-basins, was $3.25 per foot in length. The cost per foot of over one hundred miles of twelve-inch pipe-sewer, not including catch-basins, was $1.44; of five miles of fifteen-inch pipe, $1.63; of ninety-five miles of two-foot sewer, $2.34. These three sizes would probably be used in a separate system, but a larger proportion of it would consist of smaller pipes.

On the Chicago basis of prices, probably $1.30 per foot is a fair average for the cost of a separate system. The first twenty miles of sewers built at Memphis are said to have cost

exactly $1.30 per foot. This included an undue proportion of main sewer, and also the expense of engineering: on the other hand, the trenches were unusually shallow, and a saving of at least thirty cents a foot was made by omitting manholes; a saving of questionable expediency, and no more a part of the system than is the admirable regulation of house-

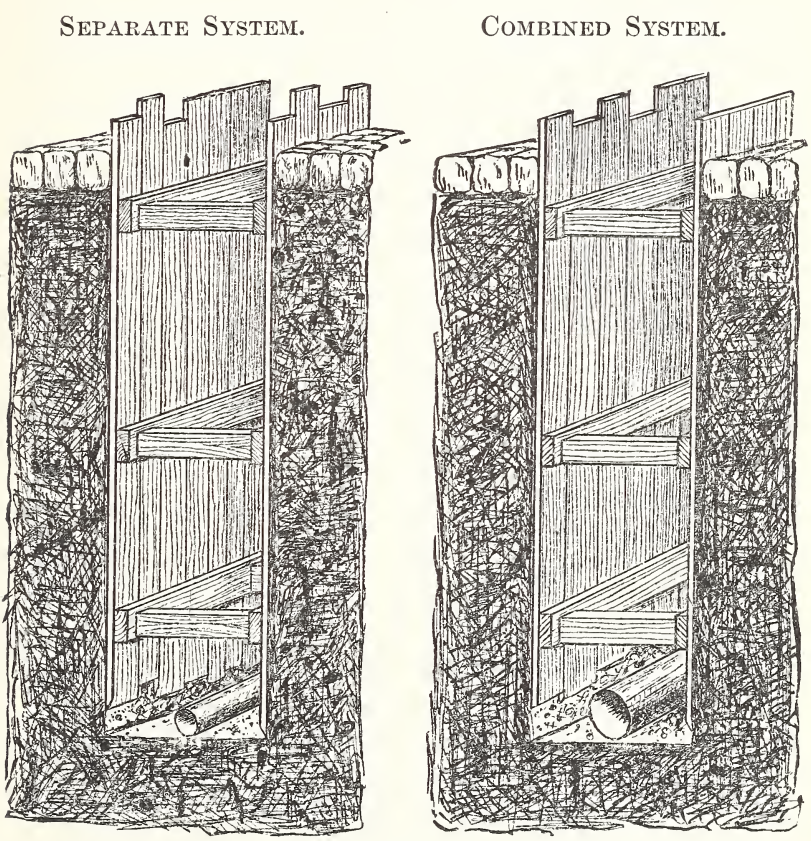


Fig. 4.

drainage at the same city. Comparing $3.25 and $1.30, it appears that the first cost of a combined system will be two and a half times that of a separate system not admitting rain.

That the difference is not greater, is due to the fact that many elements of expense in sewer-construction do not much depend on the size of the sewer built; such as engineering

and superintendence, pumping of water, sheeting of trench, repairs to roadway, and various other items. By referring to Fig. 4, which represents the branch sewers of the two systems, that is, six and twelve inch pipes, in their trenches, it will be understood that the difference in their cost will consist almost entirely of the difference in price of the pipes themselves, or about twenty-five cents a foot; and that, as the cost of excavation increases, owing to the presence of quicksand or other material difficult to manage, this disproportion in price may become insignificant.

Although the saving in first cost, by adopting a system of sewers not admitting rain, is about two dollars a foot, or over ten thousand dollars a mile, yet the question of its economy depends on other considerations. A further saving would be made of the cost of cleaning the street catch-basins, amounting to about two dollars a year for each basin, or seventy dollars a mile, which is the interest on about twelve hundred dollars more. If any additional sewers for rain were needed, the saving would be diminished by their cost. The extra expense for building and maintaining street gutters and culverts should be treated as interest on a sum to be deducted in calculating the saving. So, also, should all pecuniary damage caused by the lack of prompt removal of the rain-water; especially the damage to street surfaces which would be gullied and washed away in time of storm. At Boston a single storm has entailed an outlay of ten thousand dollars, all expended on repairs to unsewered streets, and which would not have been needed had the rain been intercepted at frequent sewer inlets. In 1824 Josiah Quincy, then mayor, said, referring to the taking control of sewers by the city in the previous year, "Considering the effect which well-constructed drains must have upon the city expenditure, in respect of the single article of paving, there can be but one opinion upon the wisdom and economy of this system."

6. There are many towns where it is quite practicable to dispose of surplus rain-water otherwise than by means of sewers; but it is begging the question, to claim that since the rain flowed over the surface everywhere, before the introduction of sewerage, it can continue to do so, for the same sort of reasoning would apply to the sewage itself. There is no question but that the rain must be got rid of, nor that in

populous districts it must flow in the streets; but it is a question how far it can be made to flow there without becoming too great a nuisance.

On this point there may be differences of opinion; and it must be settled by each individual for himself, from his personal observations. It may be stated, however, that in cities where intervals of more than from three to four hundred feet are left between catch-basins, neighboring residents are apt to complain that the amount of water on the street, in time of heavy rain or thaw, is a nuisance; but then, city residents are often too exacting in matters concerning their comfort. Certainly the street roadway is more easily kept in good condition where the rain is frequently intercepted. In such cases the ordinary crown to the street throws the water to the sidewalk curb, whence it flows to the nearest basin in a stream so small as to require no gutter and no noticeable elevation of the cross-walks.

As a single street is frequently the outlet for the drainage from ten or even fifty acres, which amounts to from five to twenty-five or more cubic feet each second, where there are no catch-basins there must be gutters large enough for this quantity of water. If these channels are shallow they take up much room; if deep they are somewhat dangerous. At the cross-walks must be bridges or stepping-stones, against which the wheels of vehicles often strike. At street crossings, the gutters, if on the surface, are troublesome to heavily loaded wagons, and, if carried under by culverts, are apt to be clogged by rubbish and ice. If a street is flat, its gutters must be large; and, if steep, the running water will wear away the ground and necessitate frequent repairs. In a heavy rain, even where catch-basins are not more than four hundred feet apart, the rain begins to gully the street surface or wash out the filling between paving-stones. After snow-storms and cold weather, a rain or thaw is apt to find the gutters filled with ice and inoperative. It should be added, however, that in the latitude of Massachusetts catch-basins also sometimes freeze up and cause trouble; but this can be prevented, or they can be thawed out with salt.

If the rain is not removed by means of sewers, it is evident that all areas to be drained, such as yards, passage-ways, and courts, must be higher than the streets, and that the latter

must have continuous slopes towards the water-course into which they in turn drain. In the combined system a yard may be below the street, at any elevation higher than that of the nearest sewer, and yet drain into it through a special basin. A street may descend and rise again, or may be built at different grades, provided only that catch-basins are located at its lowest points.

Where the rain-water was not permitted to enter the sewers, there would be a constant temptation to introduce it surreptitiously, in order to drain low premises; and continual vigilance would be necessary on the part of the authorities to detect and prevent this. To allow it in even a few cases would be inadmissible; since the rain-water from twenty buildings, or a less number of yards, might exceed in amount the average quantity of sewage from a population of ten thousand persons. There is no doubt that the removal of rain at frequent inlets, by means of underground conduits, is always a great convenience, and often, in cities at least, absolutely essential.

7. To build a separate set of sewers for the rain alone, presents no especial difficulty. The sewers must be as large as if intended to convey the sewage also: therefore, if they were placed equally low, the cost of a double system would be two-fifths greater than that of a combined one. As the larger set of the double system would not, however, be called on to drain low cellars, its sewers could be less deep than would otherwise be needed, and their cost lessened. As the rain-water would not be so offensive as an equal quantity of sewage, another saving might be made at some places by discharging the rain at more, and less distant, outlets into any small water-courses intersecting the district. The two sets of sewers might interfere with each other as to position; and, where they crossed each other, as to their grades. Constant care would be necessary to insure connections being made with the proper sewer. These difficulties would be in a great measure avoided where the town was laid out in such manner that the small sewers could be built in alleys behind the buildings, and the large ones in front below the streets.

It is difficult to see how the sewers of the double system would perform their respective functions more efficiently. The small sewers would lack the periodical flushing by rain-

water; and during a very light rain of short duration considerable street-refuse might be carried into the large sewers to remain and decompose until the next shower. But, as these sewers would not be connected with the houses, this would cause no danger, and, if they were well ventilated, little annoyance.

8. It is probable that in the near future many inland towns will be prohibited from polluting rivers and streams by discharging their sewage into them. It will then be necessary to seek other methods of disposing of it. The most common of these is surface irrigation, but filtration or chemical treatment may sometimes prove useful. In any such case, if it can be shown that the admission of rain to the sewers will interfere with these operations, it should be avoided. Although hitherto sewage has seldom been artificially raised in this country, there is little doubt that in the future pumping will often be resorted to; and it would be almost impossible to pump quickly enough the rain falling on a large district. Even in these cases, however, it does not follow that the rain must of necessity be excluded from the sewers. What is necessary is to prevent too much water reaching the pumps, sewage-farm, filter-beds, or place of treatment. This can generally be accomplished by building the main sewer which leads to these points just large enough for the sewage proper, and extending it to intercept the sewage as it flows in the ordinary sewers, at points near their outlets, through which the excess of rain during storms would still discharge freely. It is true that at such times, the rain and sewage being mixed, a portion of the former would reach the pumps, and some of the latter flow into the stream. If, however, the intercepting sewer were somewhat larger than was needed for the sewage alone, as it probably would be, the polluted water of a very light rain and the foul first portion of a heavy one would also be intercepted, so that probably by this method no greater amount of objectionable matter would reach the stream. When pumping is resorted to because the town site is so low that its cellars cannot be drained by sewers discharging into the neighboring stream or pond, a separate system becomes a necessity; for the rain, if admitted to the sewers, must either be pumped, or flood the cellars, and must therefore be otherwise disposed of.

The result of this discussion appears to show that a separate system of sewerage is only necessary where cellars are so low that they must be drained by pumping; that in other cases its only merit is its cheapness; that the saving, in first cost of sewers, where all of the rain flows off over the ground, will be about three-fifths, depending on the character of the soil; that the final economy will depend on circumstances; that the system would only be advisable where the branch sewers could incline not much less than one in one hundred; that surface drainage for rain is attended by a varying amount of inconvenience and damage, which increases with the growth of a town.

Although the general principles which govern this problem are comparatively simple, yet it would probably be unwise for any town to attempt its solution without the advice of an expert who had carefully considered all the conditions affecting that locality.

March, 1881.

INTERMITTENT FEVER IN MASSACHUSETTS.

BY

J. F. ALLEYNE ADAMS, M.D.,
OF PITTSFIELD.

INTERMITTENT FEVER IN MASSACHUSETTS.

The recent appearance in Massachusetts of intermittent fever is a surprising and interesting event. History and tradition have informed us of its prevalence at the time of the first settlement of the country, when people built their houses on the hill-tops, to escape the malaria of the valleys; but, with the clearing and cultivation of the country, it wholly disappeared. During the present century, it has been, with very trifling exceptions, unknown as an indigenous disease: our cold climate has seemed unfavorable for its development, and it has confined itself to the warmer parts of the United States. But in 1850 this disease obtained a foothold in Connecticut, on the shore of Long Island Sound, and about 1864 began a northward march across the western half of Connecticut, and has steadily pushed forward, until, in 1876, it reached the northern border of the State, and thence, ignoring the boundary-line, stepped over into Massachusetts, appearing in Sheffield in 1877. But, previous to this date, a few cases had appeared in three localities; viz., in Springfield since 1870, New Marlborough since 1874, and Holyoke since 1875. In 1878 the disease appeared at Agawam and New Lenox; and in 1879 and 1880 it made a rapid advance, invading a considerable number of towns.

Naturally enough, this visitation is not a welcome one to the people of Massachusetts, who are sorry to see another added to the list of prevailing diseases; and yet a crumb of comfort may be found in the, fact which has been frequently observed, that the appearance of intermittent fever is apt to be attended with the partial disappearance of typhoid-fever. Whether there is any relation of cause and effect between these two circumstances, it is impossible to say; but, even if

there is, the apparent primary benefit of having a milder disease substituted for a very severe one is more than cancelled by the fact, that, in its later manifestations, malaria develops other affections of a graver character, and seriously complicates many other diseases.

The new appearance and gradual spread of this disease is a somewhat rare phenomenon, affording an excellent opportunity for studying its natural history, and observing by what conditions it is most favored. Therefore the present inquiry has been undertaken, in the hope of obtaining some data which may suggest practical measures for its arrest or limitation, or may at least prepare the way for further and more thorough investigations.

A brief history will first be given of the early appearances of intermittent fever in Massachusetts and other New England States; and this will be followed with a description of the recent epidemic. In considering the latter, the progress of the disease through Connecticut will first be described, as a necessary preliminary to the account of its appearance in Massachusetts. In considering the information relating to our own State, the arrangement has been adopted of taking up each county separately, beginning at the west and proceeding toward the east; and, in the four western counties, of taking the towns *seriatim* from south to north. This order is, in the present instance, a natural one; since it very nearly coincides with the course taken by the malarial influence.

I. — HISTORICAL.

To Dr. O. W. Holmes[1] we are indebted for the only complete historical account of intermittent fever in this and the other New England States. Writing in 1836, he found that the disease was then almost unknown, and that the periods of its prevalence had been of much earlier date. His facts relating to Massachusetts may be briefly summarized as follows: —

Berkshire County.

Sheffield. — Dr. W. Buel wrote in 1796, that people living in the vicinity of the "marshy and drowned lands," along

[1] Facts and Traditions respecting the Existence of Indigenous Intermittent Fever in New England. Boylston Prize Essay, 1836.

the Housatonic River and about the mill-ponds, had been subject to intermittent and remittent fevers since the first settlement, but that these gradually decreased until 1793. In that year intermittents were very prevalent, especially in the vicinity of the "North Pond." In 1794 bilious remittents prevailed, chiefly in the vicinity of the "South Pond," which was that year drawn down for repairs. In 1795 an irregular form of intermittent prevailed, chiefly near the North Pond. In 1796 an epidemic of bilious fever and dysentery occurred near the same North Pond. On the south-east side of this pond, one-half the inhabitants were attacked, and not ten families out of a hundred escaped. There were forty-four deaths. In 1797 bilious fever, without dysentery, re-appeared in the same locality, affecting new residents and those not sick the previous year. None of the cases were fatal.

Dr. Oliver Peck wrote, in 1836, that intermittent fever prevailed sporadically from 1796 to 1820. About 1806 the disease was very prevalent at "Ashley's" (Ashley Falls), in the vicinity of a mill-pond. The dam was removed, the pond converted into a meadow, and the disease disappeared. About 1810 there was a prevalence of intermittents about "Bush's" Pond, in the south-west part of the town. In 1820 the disease was more prevalent than at any time since 1796, in the vicinity of the same North Pond; and again, to a less extent, in 1832, the dam being that year kept higher than usual.

Somewhere about 1828, says Dr. Peck, "a dam was thrown across the Housatonic in Connecticut, a mile or two below the line dividing the States: this raised the water in the river within this town, causing the low ground and meadows to be more frequently overflowed. An intermittent of some extent followed, and prevailed for a year or two, until the dam was lowered by order of the courts of Connecticut. Since then, I have not known of a case near that locality, though there may have been now and then one."

[In Dwight's "Travels," [1] published in 1821, Sheffield is spoken of as having always been subject to fever and ague, and the epidemic of 1795 is alluded to.]

Dr. Peck, who still resides in Sheffield, has recently in-

[1] Travels in New England and New York, 1821, vol. ii., p. 378.

formed the writer that the disease has been of very rare occurrence since 1832, until within three years. Dr. J. Leland Miller, who has lived ten years in Sheffield, says he never heard of a case until the past three years.

Great Barrington. — Dr. Oliver Peck wrote, in 1836, that intermittents had prevailed here for some years past, though he could not say to what extent. It was limited to the vicinity of the river, and attributed to the foul water of the coves.

Stockbridge. — Dr. Stephen W. Williams of Deerfield wrote to Dr. Holmes in 1837, and quoted from the "Historical Memoirs of the Housatunnuk Indians," as follows: "Mr. Sergeant of Stockbridge was to be ordained at Deerfield in 1753, and was delayed by 'intermitting fever,' — the common distemper of all new-comers to Housatunnuk." Dr. Oliver Partridge of Stockbridge wrote, that in 1771 there were some cases of fever and ague in Stockbridge. In 1795 "bilious remitting fever" was epidemic in Stockbridge and surrounding towns.

West Stockbridge. — Dr. Partridge wrote, that, toward the latter part of the last century, a dam was built in this town, raising a large pond on land covered with trees and brushwood; and this became a noted place for fever and ague. In 1795 bilious remittent fever prevailed.

Pittsfield. — Dr. Buel wrote in 1796, that intermittent fevers were formerly very prevalent in Pittsfield, but became nearly extinct in consequence of agricultural and other changes. In 1836 Dr. Holmes received a letter from a gentleman of this town, stating, that, "between forty and fifty years ago (1786–96), a mill-dam, erected near the village, caused the water to set back, and cover more than one hundred acres covered with native forest. Soon after, all the timber perished. Then commenced bilious fevers and fever and ague. It was very sickly: many died; all were alarmed. The owner of the mill was prosecuted, and the dam destroyed. The sickness ceased soon after the removal of the dam." Dr. Childs stated in 1836, that he had that year met with more cases of intermittent fever than for twenty years past, in consequence of the removal of a dam. The rivers, also, were very low at that time.

Adams. — Dr. Childs spoke of having seen cases of intermittent fever at Adams in 1836.

Connecticut Valley.

Northampton. — Dr. Charles Seegur wrote to Dr. Holmes as follows: "In 1792 a company, most of them Hollanders, built the South Hadley Canal, eight or ten miles below the centre of Northampton, to convey boats and rafts around the falls. A dam was made at the head of the falls, eleven feet high, across the river, which raised the water, for ten miles above, four feet above the common level. In consequence of this, the spring freshets flowed back much farther than before, and left large quantities of stagnant water when they withdrew. A great many of the inhabitants of this town, living and working near and amidst these low, marshy places, were, for several years afterwards, afflicted with the fever and ague, which was unknown in this town for more than sixty years. Several of the inhabitants instituted suits against the proprietors of these works, under the nuisance-law, which compelled the latter, some years after, to remove the dam, and deepen the canal sufficiently to fill it without the aid of the dam. After removing this cause, its effect, of course, gradually ceased, and the town recovered its character of a healthy place." A gentleman of Dr. Holmes's acquaintance told him, that when at Round Hill School, in 1824, he had an attack of fever and ague; but he was not aware whether others had the disease.

Deerfield. — Dr. Holmes quotes Dr. Stephen W. Williams as saying that his father, who was a physician, had told him, at the time of the erection of a dam across Deerfield River, at Stebbins's Meadows, in 1793 or 1794, fever and ague prevailed in several families living on the banks of the river at that place. Mr. Robert Bardwell took fever and ague while boating on the river between Deerfield and Hartford, between 1793 and 1798. No cases had originated in Deerfield since that time.

Hatfield. — Dr. Oliver Partridge of Stockbridge stated, in the letter to Dr. Williams previously referred to, that he contracted intermittent fever in Hatfield in 1795, the disease being then prevalent there.

Greenfield. — Dr. Stone of this town wrote to Dr. Holmes, that in 1805 he had two cases of tertian ague originating in Greenfield; the persons affected living near a saw-mill pond,

which was drawn off in the spring later than usual, giving rise to a stench which was insupportable.

Eastern Massachusetts.

Groton. — Dr. Holmes adduced evidence to show that intermittent fever prevailed in Groton many years ago, but no dates are given.

Plymouth. — Dr. Thacher of this town wrote to Dr. Holmes, that about thirty years before (1806) intermittent fever of a mild tertian type affected two families living near a swamp, the water of which had been recently drawn off, leaving an extensive surface of muddy ground.

Hopkinton. — Dr. Stimson (in historical collections) says, "Before the swamps were cleared and drained, the inhabitants used to be very subject to the fever and ague; but since, there have been no complaints of the kind in the town."

Dr. Holmes quotes from "Mann's Medical Sketches," 1816, as follows: "Intermittent fevers, one hundred years ago, were common in the lower towns of Massachusetts, where a single case has not been known to have originated within the last fifty years."

Boston. — Dr. James Jackson furnished Dr. Holmes with an account of what was apparently an indigenous case of intermittent fever, which he had seen "a number of years since," in consultation with Dr. Dixwell. The patient was a lady residing in Essex Street. She died in a congestive chill.

Connecticut.

New Haven. — In Hubbard's General History of New England, "ague and fever" is mentioned as one of the common diseases of the colony of New Haven in its early history. Dr. Eli Ives informed Dr. Holmes that the disease had been known there from time immemorial: a few cases had occurred since 1800, but not a case for twenty-five years.

Greenwich. — Mentioned as prevalent by Dr. Clark Sanford in 1811.

Housatonic Valley. — Dr. William Buel spoke of the disease having prevailed in this valley, in the vicinity of dams, and of its disappearance on their removal. He believed its prevalence there had, for the past twenty or thirty years, been diminishing.

New Milford. — Bilious remittent fever, and fever and ague, were very prevalent here in 1796, 1797, 1798, and 1799, in the vicinity of a dam. Some of the citizens removed a portion of the dam, which led to an action for trespass, brought by the owner. A trial followed in 1800; and much testimony was introduced on the part of the defendants, to prove the dam a nuisance, and on the part of the plaintiff, to show that the sickness was independent of the dam. This was the result: "It was obvious to all the hearers of this trial that the more proof the more doubt, and that the question grew more perplexed by investigation. And so fully were the court and jury impressed with this idea, that they decided in favor of the owner of the dam, and gave damages accordingly, saying that they could not find it proved a nuisance."[1]

Litchfield. — According to Dr. Buel, the disease prevailed in the early settlement of the town, in the vicinity of a dam, which was thrown across the Bantam River for the purpose of killing timber.

[Dr. Bronson of New Haven says that the disease appeared in 1828 on the Sound in Fairfield County, coming from the southwest across the New York border, and extending as far as Housatonic River, which it did not cross. It prevailed in Norwalk, Westport, Fairfield, and other places, until 1832, when it disappeared.]

Rhode Island.

Providence. — About 1758 a dam was thrown across the Moochassuck River, and a tertian fever prevailed in its vicinity. None had been known for fifty years at the time of the report (1836).

South Kingston. — In 1777 three cases occurred among some soldiers encamped in a low, wet place at Quidnesset Point.

Cranston. — Three cases occurred "forty or fifty years ago."

Vermont.

Burlington. — Intermittent fever prevailed in February and March, 1811 (Mann's Medical Sketches).

[1] An account of this trial may be found in the Memoirs of the Connecticut Academy of the Arts and Sciences, Vol. I.

Maine.

Poland. — A single case in 1830 was reported by Dr. J. W. Mighels; but the description of the case shows that the chills were probably due to hepatic disease.

II. — THE RECENT EPIDEMIC.

Connecticut.

For a period of forty years after the date of Dr. Holmes's essay, intermittent fever of domestic origin was, in Massachusetts, almost unheard of. The interval of immunity in Connecticut, however, was less protracted. Of its appearance in and progress through that State, a most complete and interesting history is to be found in two very valuable papers published in the Proceedings of the Connecticut Medical Society; one by Dr. Henry Bronson[1] of New Haven, in 1872, the other by Dr. A. W. Barrows[2] of Hartford, in 1877.

From these two reports the following chronological table, showing the date of its first appearance in different places, has been chiefly compiled; a few towns being added, the facts concerning which have been learned by correspondence with local physicians.

1850. New Haven. Beaver Ponds.
1851. Stamford.
1853. Norwalk.
1855. Black Rock.
1863. West Haven.
1863. Lake Whitney.
1864. City of New Haven.
1864. Wethersfield.
1865. Westville.
1865. Bridgeport.
1866. North Haven.
1866. Wallingford.
1868. Portland.
1870. Hanover (South Meriden).
1870. Meriden.
1870. New Milford.
1871. New Britain.
1871. Haddam.
1871. Birmingham.
1872. Middletown.
1872. Rocky Hill.
1872. Hartford.
1872. East Hartford.
1875. Newfield.
1876. Windsor.
1876. East Windsor.
1876. Enfield.
1876. East Haddam.
1877. Stafford Springs.
1877. Columbia.
1877. Waterbury.
1877. Salisbury.
1878. North Granby.
1878. Kent.
1878. Falls Village.

[1] History of Intermittent Fever in the New Haven Region.
[2] On Malarial Fever in New England.

From a report of Drs. Lindsley, Barrows, and Buell,[1] to the Connecticut Medical Society, we find that the disease was prevailing in the year 1877, in addition to those enumerated above, in the towns of Bethel and Huntington in Fairfield County; Bradford, Cheshire, Derby, Guilford, Madison, and Waterbury, in New Haven County; Durham, Chester, and Essex, in Middlesex County; Old Lyme, in New London County; Berlin, Bristol, Collinsville, and Glastenbury, in Hartford County; and New Preston, in Litchfield County. The date of its appearance in these towns is not stated: in some of them it is known to have been several years before.

The Secretary of the State Board of Health of Connecticut, Dr. C. W. Chamberlain of Hartford, in a letter written Jan. 24, 1881, says, "Malarial diseases are very prevalent along the valley of the Quinnipiac and of the Connecticut, considerably so in the valley of the Housatonic, and not at all in the valley of the Thames; but little, if any, in the eastern part of the State."

To show the conditions under which malarial diseases have appeared in Connecticut, the following brief extracts are made from the reports above referred to: —

New Haven and Vicinity. — First appeared in 1850, near Beaver Ponds, north-west from the city. From this time, a few cases appeared each year, until 1864, when as many as seventy cases occurred in West Haven, near a saw-mill pond formed by the erection of a dam in 1860. The pond was shallow and full of rotting stumps. In 1863 it began to prevail about Lake Whitney on Mill River, the reservoir of the New Haven Water Company, completed in 1861, and thence spread in the succeeding years to the manufacturing villages up the river. In 1865 it began to attract attention at Westville, on the West River, where in 1867 it visited fifty-one houses out of fifty-eight nearest Blake's Mill. In 1866 it appeared in North Haven, in the vicinity of the brick-yards, and thence spread up and down the valley of the Quinnipiac. The first cases in the city of New Haven were in 1864, in the north-western portion of the city, near the Beaver Ponds and Westville. It remained limited to this section until 1870, when it increased in prevalence,

[1] Report of the Committee on Matters of Professional Interest in the State. Proceedings Connecticut Medical Society, 1877, p. 41.

and extended over a considerable portion of the city. In that year, which was a season of drought and low water, it became more prevalent than before in the vicinity of the reservoir, and affected nearly every family on both sides of the River Quinnipiac, in North Haven and Wallingford, and extended to Hanover (South Meriden).

Stamford. — Not confined to any locality, but most common around the river, mill-pond, and marshy places.

Norwalk. — Limited to a belt five miles wide, along the shore and railroad.

Bridgeport. — First appeared on the east side, near the river and ponds, but afterwards spread to the higher grounds.

Hartford. — First appeared in 1872, in Wethersfield Avenue, near the southern boundary of the city. At that time a large sewer-main was being laid through the low grounds, sixty or seventy rods west of the avenue, and parallel with it; and a railroad was also being built parallel with the avenue, on the east, involving the extensive turning of the alluvial soil. In 1876 there was an increased number of cases in this part of the city. Wethersfield Avenue was then being graded, and the summer was hot and dry. The same year it prevailed in the north-eastern section of the city, near the Connecticut River, and in close proximity to a new railroad.

East Hartford. — First appeared in 1872. Sporadic cases appeared in various parts of the town in that and the next three years. In 1876 the disease became epidemic along the river-bank; seventy per cent of persons living near the river were attacked; there were very few cases in other parts of the town. The river was very low that year, and an island twenty acres in extent was formed by the uncovering of a flat near the eastern shore. At high tide this island would be mostly covered, at other times it was bare.

Windsor and East Windsor. — These towns lie next north of Hartford and East Hartford, on the Connecticut River. Cases first appeared in 1876 in both towns.

Portland and Glastenbury. — First appeared on the borders of the Connecticut, and gradually extended inward, following the streams.

Meriden. — Appeared in 1870, and has prevailed in all

parts of the city; the immediate cause supposed by Dr. Catlin to be the grading of the streets, and the raising of dams of mill-ponds, exposing large quantities of decayed vegetable matter to the rays of the sun.

New Britain. — First attracted attention in 1871; the cases being confined to no one part of the town. No local cause could be assigned, aside from the grading of streets, and opening of trenches for sewers and water-mains. In 1876 it became epidemic in a farming-district in the vicinity of a pond which became dry during the summer. Out of eighty persons living near the pond, fifty-five were attacked. A small pond in another part of the town became dry in the summers of 1875 and 1876, and a few families living near it were attacked in each of these years.

Haddam and East Haddam. — A general epidemic prevailed in 1871 and 1872, after the completion of the railroad, near which most of the cases were found. In 1876 every one of twenty families living near Goodspeed's Station was visited by the disease. The same year similar epidemics occurred at Goodspeed's Landing, and East Haddam Landing, on the opposite side of the river, in East Haddam. Near each of these localities, artificial ponds dried up in 1876.

Middletown. — Appeared in 1872, increased till 1876, when it seemed to be on the decline, the cases being less severe and less frequent. Persons living on the highest as well as the lowest grounds suffered; but it was most frequent in low places and on the borders of streams. There were no local causes which had not existed prior to 1872.

Newfield. — Most abundant in the region overflowed by spring freshets. Very prevalent in 1875 and 1876. A clay subsoil renders the ground very retentive of moisture.

Cromwell. — Persons exposed to the night breezes from the river, even from having their windows open in that direction, were invariably attacked. The quarrymen, who have suffered severely, are accustomed to congregate at evening on or near the bank of the river.

Rocky Hill. — In a population of less than a thousand, there were forty or fifty cases in 1875, and as many in 1876. According to Dr. Griswold, there were no appreciable causes. The Valley Railroad was built in 1870–71, but there was no intermittent till 1872. Some ponds dried up; but there

were actually no cases within two or three miles of three such ponds which became dry in 1876, while other localities suffered severely. This town is on the west bank of the Connecticut, which has an annual overflow, leaving much alluvial deposit.

Berlin. — The disease is said not to have appeared on the trap elevations, but to have followed the streams.

By correspondence with physicians in towns not included in the reports above quoted from, the following additional information has been received.

Enfield. — Dr. R. S. Strickland states that intermittent fever first appeared in 1876; that the number of cases the past year has been large, and mostly occurred on low lands or near the river.

North Granby. — Dr. George W. Edwards reports that intermittent fever first appeared in 1878; that three cases occurred the past year, of quotidian type; and that the cases are not limited to low, wet places. He adds that there have been perhaps fifty cases the past year of a mild form of remittent fever.

Litchfield. — Dr. Willis J. Beach reports that intermittent fever has not yet appeared in Litchfield.

New Milford. — Dr. James Hine states that a case or two occurred first in 1870, and about the same number each year till 1879, when the number was greatly increased. The number of cases in 1880 was about three hundred; type, tertian and quartan. The disease has been confined almost exclusively to the valleys of the Housatonic and tributaries, and has not prevailed on high lands; has shown no partiality for swampy regions.

Kent. — Dr. J. W. King reports that the disease first appeared in South Kent in 1878, and more generally in the spring of 1880. The number of cases in 1880 was twenty-five; type quotidian and tertian, especially the latter. The first cases occurred in a small suburb called Alder City, one and a half miles from the village, and located by the river; and the cases have generally occurred near the river, the water in which has been very low the past season.

Salisbury. — Dr. John H. Blodgett states that the first cases occurred in 1877, and that the number of cases in 1880 was over a hundred. The first cases occurred on the banks

of the Housatonic River; and it has since prevailed on the borders of streams and ponds in Amesville, Weatogue, and Chapinville.

Falls Village. — Dr. Charles B. Maltbie reports that the first cases appeared in the summer and fall of 1878 on the banks of the Housatonic, to which locality they have since been limited. The number of cases was much less in 1880 than in 1879.

Waterbury. — Dr. F. E. Castle reports that the disease first appeared in 1877; that he has treated, during the past year, from six to ten cases of intermittent fever: the form is mild, and yields readily to treatment. It prevails on high as well as low ground, and he can see no difference in this respect.

To these local reports may be appended the following extract from the registration report of the State of Connecticut for the year ending Dec. 31, 1879.[1] Dr. Chamberlain, Superintendent of Registration of Vital Statistics, reports that "malarial fevers have increased steadily. In 1877, forty-five deaths; 1878, a hundred and forty-five; in 1879, a hundred and ninety-eight. The congestive type is also well marked, and in some instances fatal in less than twenty-four hours. Unconsciousness and coma rapidly supervene; enlarged spleens are met with more frequently; malarial broncho-pneumonia, enteritis, and cystitis are reported; while various forms of anæmia, and especially of infantile debility, are ascribed more or less accurately to malarial influences. One hundred and seventeen cases of typho-malarial fever are reported. There is some doubt expressed with regard to the diagnosis of these cases, whether they are not really purely typhoid. This may be true in some cases; but there are, without the least doubt, a large number of mixed cases, so closely related and uniform in symptoms as to deserve the name typho-malarial; and, as can readily be seen, these cases are increasing. Cerebro-spinal meningitis, now endemic, is about as frequent as in 1878, occurring more especially in malarious districts."

A table showing the annual number of deaths in Connecticut from typhoid and malarial fevers, for a period of ten years, has been prepared by Dr. Chamberlain, and published

[1] Page 76.

by Dr. J. L. R. Wadsworth[1] of Collinsville, Ill. This shows that the deaths from typhoid fever in 1869 numbered four hundred and fifty-eight; and in 1878, two hundred and fifty-two: from malarial fevers in 1869, nine; and in 1878, one hundred and forty-three. The year 1878, which was characterized by a doubling of the deaths from malarial fevers, shows sixty-nine less deaths from typhoid than the preceding year.

Rhode Island.

Providence.— Dr. G. T. Moreau has furnished an account of an outbreak of intermittent fever at Nayatt Point, near Providence, in the summer of 1880. He says, "During the last five months, I have had one hundred and sixty-three cases at Nayatt, R.I. The intermittent form prevailed. Many of the cases were at first remittent, and became intermittent after six, eight, or ten days, some later. Only two typho-malarial cases. The tertian type prevailed, but many were quotidian. I have not known of any cases of quartan. No fatal cases. These cases occurred in the summer of 1880, commencing at the last part of July. The persons reside, most of them, at a brick-yard, with swamps and ponds near. I heard that one of those swamps became dry last summer, not having been so for many years. No cases have been known in this vicinity in previous years, nor in any town adjacent."

Massachusetts.

The facts concerning the appearance of malarial fevers in Massachusetts have been obtained by correspondence, and, in several localities, by personal observation and inquiry. In June, 1880, circulars were sent to physicians or boards of health in every town in the State, asking whether cases of any form of malarial fever had occurred during the past or previous years. Postal-cards were enclosed for replies. To those making affirmative answers, additional circulars were sent, asking for detailed information as to number of cases, form, type, season, whether any fatal cases, locality (whether near any swamp, pond, stream, or reservoir), date of first appearance, etc. Replies were mostly received during the

[1] "Malaria." President's annual address before the Madison County (Ill.) Medical Society, April 27, 1880.

months of July and August. By subsequent correspondence and inquiry among physicians, additional information has been received from a considerable number of towns, covering the summer and fall of 1880.

By these means, the existence of some form of malarial fever has been discovered in forty-eight cities and towns, and information that no such cases have appeared has been received from one hundred and sixty-three. From one hundred and twenty-eight towns, no answer has been received. These are generally the most remote and sparsely populated. The towns heard from comprise nearly two-thirds of the whole number in the State, and include almost every place of any size or importance.

Of the forty-eight cities and towns, ten report one case, six two cases, two three cases, three four cases, three five cases, three six cases, and in three the number is not stated. This leaves eighteen places reporting more than half a dozen cases. Of these, six are in Berkshire County, seven in Hampden County, and five in Hampshire County. Those in Berkshire are Sheffield, New Marlborough, Great Barrington, Lenox, Lanesborough, and North Adams. Those in Hampden are Longmeadow, Agawam, Springfield, West Springfield, Chicopee, Holyoke, and Southwich; and those in Hampshire are South Hadley, Northampton, Easthampton, Hadley, and Hatfield.

The four counties of Suffolk, Norfolk, Dukes, and Nantucket, report no cases, and Essex and Plymouth report only one each. In the circulars inquiry was made as to the three forms of fever, — intermittent, remittent, and typho-malarial. Most of the replies contained reports of intermittent only, but some towns reported also remittent fever. In a few cases, typho-malarial fever was also reported: but it appeared that a misapprehension existed as to the definition of the term; for the cases reported were, in most cases certainly, and in all probably, typhoid fever. These are therefore omitted from the tabulated statement, as tending only to confuse; and in the answers from correspondents, such cases are retained only where there seems a reasonable probability of their possessing a malarial element. In the later letters of inquiry, only intermittent fever was referred to, as being the most typical as well as most common form of dis-

ease. This tended to simplify the inquiry, without seriously impairing the value of the information received.

The type is found in nearly all cases to be quotidian or tertian, most frequently the latter. Of the fatal cases reported, nearly all were the so-called typho-malarial.

Of intermittent fever, one death is reported in West Springfield from a congestive chill, the patient having been seen by no physician. The single case reported from Plymouth was also fatal. The two circumstances that it was the only case in the county, and was fatal, seem enough to prove its non-malarial character. The one case of remittent fever reported from Amesbury was also fatal. With these few exceptions, no fatal cases of intermittent or remittent fever are reported.

For convenience of reference, the towns reporting cases have been arranged in tabular form, by counties, giving the date of first appearance, the form, whether intermittent or remittent, the number of cases during the past year, and the locality. Following this is a list of towns reporting no cases, also arranged by counties, with the number of towns in each county not heard from.

The number of cases reported is, in some instances, known to be accurate ; in others it probably falls below the truth ; but, as far as they go, the reports are believed to be reliable, and to indicate approximately the actual and comparative prevalence of the disease.

Berkshire County.

TOWN.	First appeared.	Form.	Cases past year.	Locality.
Sheffield . .	1877	Int.	80	Near Housatonic River and mill-pond.
N. Marlborough,	1874	Int.	4	Konkapot Valley.
"	1868	Rem.	30	" "
Monterey . .	1880	Int.	2	Near Monterey Reservoir and L. Buell.
Otis . . .	1880	Int.	1	?
" . . .	?	Rem.	?	All over town.
Great Barrington,	1879	Int.	60	Near Sheffield line, and reservoir of Berkshire Woollen Co.
Stockbridge .	1880	Int.	1	Near Housatonic River.
Lee . . .	1880	Int.	4	Village, near river.
" . . .	1880	Int.	?	East Lee.

BERKSHIRE COUNTY. — *Continued.*

TOWN.	First appeared.	Form.	Cases past year.	Locality.
Lenox	1878	Int.	54	New Lenox, near Housatonic Riv.
"	1878	Int.	?	Lenox Furnace, " "
W. Stockbridge	1880	Int.	3	Village; two at State line, near swamp.
Richmond	1880	Int.	2	Near Richmond Reservoir and swamps.
"	1880	Rem.	2	
Pittsfield	1880	Int.	4	Three near N. Lenox and Housatonic River, one near Richmond Reservoir.
Lanesborough	1879	Int.	26	Near Cheshire Reservoir.
Cheshire	1879	Int.	3	" " "
North Adams	1880	Int.	13	South part village, swampy.

HAMPDEN COUNTY.

Longmeadow	1880	Int.	20	High land, remote from river.
Agawam	1878	Int.	60	Mostly near Connecticut River.
Springfield	1870	Int.	250	All parts of city.
West Springfield,	1879	Int.	200	Low lands, near Connecticut Riv.
Chicopee	1879	Int.	300	Near Chicopee and Connecticut Rivers, canals, and ponds.
Holyoke	1875	Int.	500	First appeared near Ashley Pond, also cases near river and canals.
Southwick	1880	Int.	8	High land, sandy soil.
Brimfield	1879	Int.	6	High land, but swampy.

HAMPSHIRE COUNTY.

South Hadley	1880	Int.	50	On stream draining swale lands.
Northampton	1879	Int.	100	Mostly near streams. A large percentage at " Mt. Tom Station " on Connecticut River.
Easthampton	1880	Int.	30	First appeared near two reservoirs, also at " Mt. Tom."
Hadley	1879	Int.	100	Near two mill-ponds.
Hatfield	1879	Int.	20	Meadow near new railroad.
"	1879	Rem.	17	" " "
Amherst	1880	Int.	5	One North Amherst, two Centre, two South Amherst.
Southampton	1880	Int.	5	Near Hamden Pond.
Cummington	1880	Int.	1	Wet cellar.
Huntington	1879	Int.	2	Near stagnant pool.

FRANKLIN COUNTY.

Sunderland	1880	Int.	2	Near Connecticut River.
Whately	1880	Int.	1	" " "
Deerfield	1880	Int.	1	South Deerfield.
Greenfield	1880	Int.	1	Bank of Green River.

Worcester County.

TOWN.	First appeared.	Form.	Cases past year.	Locality.
Worcester	1879	Int.	1	Site of an old pond.
Athol	1872	Int.	2	?
Westminster	1880	Int.	2	Damp bedroom.
Hardwick	1880	Int.	5	Gilbertville, near dam.
Douglas	1880	Int.	1	Near a pond.

Middlesex County.

Ayer	1879	Int.	1	Near swamp and reservoir.
"	1879	Rem.	1	" " " "
Wakefield	1880	Int.	1	High land.
"	1879	Rem.	5	Near swamp or pond.
Woburn	1880	Int.	1	Near Middlesex Canal.
Billerica	1877	Int.	1	Near pond with swampy shores.
"	1877	Rem.	3	" " "

Essex County.

Amesbury	1879	Rem.	1	Near marshes.

Plymouth County.

Plymouth	1880	Int.	1	Near stream of water.

Bristol County.

Taunton	1879	Int.	3	One near pond, two not near water.
"	1879	Rem.	3	Near swamp.

Barnstable County.

South Dennis	?	Int.	?	Near Cranberry Meadows.

The following list embraces those towns from which reports have been received showing that no cases of malarial fever had occurred. The majority of these reports are dated July or August, 1880; but a portion are of more recent date.

BERKSHIRE COUNTY.

Adams,
Becket,
Dalton,
Hinsdale,
Washington,
Williamstown, — 6
No. of towns not heard from . 11

HAMPDEN COUNTY.

Granville,
Holland,
Ludlow,
Montgomery,
Palmer,
Wales,
Westfield,
Wilbraham, — 8
No. of towns not heard from . 5

HAMPSHIRE COUNTY.

Chesterfield,
Enfield,
Granby,
Middlefield,
Pelham,
Plainfield,
Prescott,
Ware,
Williamsburg,
Worthington, — 10
No. of towns not heard from . 4

FRANKLIN COUNTY.

Bernardston,
Buckland,
Charlemont,
Conway,
Erving,
Gill,
Heath,
Leyden,
Montague,
Northfield,
Shutesbury,
Warwick, — 12
No. of towns not heard from . 10

WORCESTER COUNTY.

Ashburnham,
Barre,
Berlin,
Blackstone,
Clinton,
Dana,
Dudley,
Fitchburg,
Gardner,
Grafton,
Lancaster,
Leicester,
Leominster,
Mendon,
Milford,
Millbury,
Northbridge,
Oxford,
Petersham,
Princeton,
Royalston,
Southbridge,
Sterling,
Stow,
Sturbridge,
Upton,
Warren,
Westborough, — 28
No. of towns not heard from . 25

MIDDLESEX COUNTY.

Acton,
Arlington,
Ashby,
Ashland,
Belmont,
Cambridge,
Carlisle,
Chelmsford,
Concord,
Everett,
Framingham,
Groton,
Hudson,
Lowell,
Malden,
Marlborough,
Newton,

North Reading,
Reading,
Somerville,
Sherborn,
Shirley,
Stoneham,
Sudbury,
Tyngsborough,
Watertown,
Winchester,
Woburn, — 28
No. of towns not heard from . 22

ESSEX COUNTY.

Andover,
Beverly,
Essex,
Georgetown,
Gloucester,
Groveland,
Haverhill,
Lawrence,
Methuen,
Middleton,
Newbury,
Newburyport,
Peabody,
Salem,
Swampscott,
Topsfield,
West Newbury, — 17
No. of towns not heard from . 16

SUFFOLK COUNTY.

Boston,
Brighton,
Chelsea,
Charlestown,
Jamaica Plain,
Revere, — 6

NORFOLK COUNTY.

Bellingham,
Braintree,
Brookline,
Canton,
Foxborough,
Franklin,
Holbrook,
Hyde Park,
Medfield,
Norwood,
Sharon,
Walpole, — 12
No. of towns not heard from . 11

PLYMOUTH COUNTY.

Duxbury,
East Bridgewater,
Halifax,
Hanover,
Hanson,
Hingham,
Kingston,
Marion,
Marshfield,
Pembroke,
Rockland,
South Abington,
Scituate,
South Scituate, — 14
No. of towns not heard from . 12

BRISTOL COUNTY.

Attleborough,
Berkley,
Dartmouth,
Easton,
Fairhaven,
Fall River,
Mansfield,
Mattapoisett,
New Bedford,
Norton,
Seekonk,
Somerset,
Swansea,
Westport, — 14
No. of towns not heard from . 4

BARNSTABLE COUNTY.

Brewster,
Chatham,
Hyannis,
Orleans,
Provincetown, — 5
No. of towns not heard from . 8

DUKES AND NANTUCKET.

Edgartown,
Vineyard Haven,
Nantucket.

A more detailed account of the appearance of the disease in each town will now be given. This is collated from a mass of circulars, postal-cards, and letters; in most cases greatly condensed, without omitting any essential points. In several instances, letters are given entire. The same order is still observed, in the four western counties, of proceeding from south to north. Several correspondents have furnished very interesting details of treatment. These have been omitted, as not coming within the scope of this report. It may here be said, however, that all agree in bearing testimony to the curative power of quinine, and the other alkaloids of cinchona-bark.

Sheffield. — Intermittent fever first appeared in this town in 1877, attained its greatest prevalence in 1879, and has continued in 1880. This is one of the towns formerly visited by the disease. The Housatonic River runs circuitously through the town, with many coves and pools in the adjacent meadows. In the northern part of the town is "Mill Pond," called "North Pond" by Dr. Holmes. This pond has been in existence since the first settlement of the town, but was enlarged by raising the dam, ten years ago. It is less than a mile in length, and less than a quarter of a mile in width. The vicinity of this pond was the principal seat of intermittent and bilious remittent fever in 1793–97. In August, 1880, Dr. J. L. Miller of Sheffield showed the writer the houses in which he was cognizant of the occurrence of this disease. They were mostly in the vicinity of this pond, some close to its border, and others at various distances up to a mile. The average distance was about one hundred rods. The pond is distant from the river only from one hundred to two hundred rods, and several of the houses were between the pond and the river. Two of them were at the foot of the mountains, one-quarter of a mile east of the river. Cases had occurred in all directions from the pond. They were all very mild, and most of the people had at that time recovered. The water was four feet below the dam, and the bottom of the pond was mostly bare. It was chiefly sandy, with but little mud. Grass grew in places, and cows were grazing, showing that the water had been low early in the season. The number of cases in this vicinity was about twenty. Dr. Miller knew of a very few more in other parts of the town. These were in

the village, near the river. The river was then low, with mud exposed on its banks; and the meadows were full of pools and coves, formed by former freshets, which contained stagnant water. Dr. Miller, who has lived in Sheffield fourteen years, said that he never heard of a case of chills and fever in the town until 1877. Dr. Oliver Peck, who has lived there for sixty years, and is still vigorous in mind and body, told the writer at this time that he had known of no case of the disease in the town since 1825, when he had chills himself, which he attributed to driving twice daily past the pond.

The following letter has been received from Dr. W. P. Small of Sheffield, written Oct. 21, 1880: —

"I find, upon a careful examination of my records, that since the first of January last I have had under my care about forty cases of fever and ague; and they have occurred, with but very few exceptions, along the course of the Housatonic River, though some as far as two miles away. I believe that eighty will fully cover all the cases of 'shakes' (as they call them here) which have occurred in Sheffield this year, and I have tried to count the cases which I know to have been under the care of other physicians. As to the symptoms manifested in these cases, they are undoubtedly genuine, I am sorry to say: I speak of those under my care. For several days preceding the actual onset of the disease, there is a peculiar, continued, but more or less remitting and exacerbating, disturbance of the general health and various functions, such as loss of appetite, constipation, supra-orbital pain, and a general aching of the osseous system. These symptoms often last for several days; and the patient does not consider himself sufficiently sick to seek medical aid until the chill comes on, which lasts from one to three hours, when the fever follows, which continues from three to five hours. During this paroxysm the temperature ranges from 103° to 105° (axillary), and during the intermission the patient often feels comparatively well, and goes about his duties. Most of the cases have been of the tertian type. There is a peculiarity about the disease which deserves attention, viz., the tendency to return at the end of fourteen and twenty-one days if prophylactics are not used: this I have seen demonstrated in a great many cases during this year, and also last year, when I had seventy-five or a hundred cases. One happy feature in the disease is, that it is amenable to treatment, and very rarely the second paroxysm occurs after the proper remedies are used. Now, the subject of the cause or causes of this malaria, I do not like to tackle, although a familiar one to me, as my home was originally in eastern North Carolina, where fever and ague abound the year round, and I have seen it develop in all conditions and under all circumstances, and thus completely annihilate all theories in regard to its production. But, as to the cause of the poison in our

midst, I am fully satisfied, though others may not agree with me. Our much slandered Housatonic River is undoubtedly the most active agent in the production of malaria. For at least three successive summers the river has been very low, and the bed in great part exposed to the air, and not only the river-bed but the bogs and low lands along the river have been dry. As to what is the nature of this poison, and how it develops from the exposure of soil habitually under water, I decline to essay an answer; but I do know that where these conditions exist to the greatest degree, fever and ague has been more frequent.

"Another cause which I deem capable of producing intermittent fever is *low wells*. I will mention a case in point. On the 15th of July of this year I was called to a case upon Brewer's Hill, about two miles east of the village. The house in which the patient lived is on the highest point of the hill, several hundred feet above the river. The case presented clearly the symptoms of malarial remittent fever. I could at first assign no cause for the disease: the patient had lived in the house, a very airy and comfortable one, for five years. After a few days the hired man was taken sick, and showed precisely the same symptoms, and suffered probably more than the former case, but soon got well, under the administration of quinine. Soon a third person was attacked, the same as the preceding two. Now, the only traceable cause for this visitation lay in the well from which the family drank. The water was very low, perhaps not more than nine or ten inches; and when it was brought up was unfit for use until it settled, which required about an hour. I requested them to use water from a running spring quite a distance from the house, and not another case occurred. This is somewhat a new theory, I know; but facts are stubborn things, and I feel confident that in this case, as well as in a few others I might mention, the cause originated in the well."

In a subsequent letter Dr. Small says: —

"The intermittent fever prevailed in the vicinity of the mill-pond, especially on the plain just east of said pond. It is also true that cases occurred north of the pond, away from the river, but not to a greater extent than along the course of the river, away from the pond. But, to answer your question more directly, we have had a preponderance of cases in the vicinity of the pond, but between the river and said pond."

New Marlborough. — From Dr. Seth Pease of this town, the following letters have been received. The first was written in August, 1880.

"The type of fever that has prevailed in New Marlborough for the past year, and for the previous years since about 1868, is of a remittent type, or what I term bilious remittent. It is entirely different from the fever we formerly had to treat. An alterative and thoroughly supporting treatment is required, some of the preparations of bark being indispensable. Since about the year 1874 there has been considerable intermit-

tent fever in New Marlborough, prevailing for the most part in the Konkapot Valley, a district in the southern part of the town.

"The high water of the Konkapot River, which in the earlier part of the season frequently overflows the meadows, fills several low portions of the surface, or cove-holes; and the water cannot pass off when the river subsides, except by evaporation. This takes place slowly; but when mostly evaporated in the dry and hot weather, leaving but little water, and that in a green and slimy condition, I have noticed that in the immediate vicinity the cases of intermittent fever were more frequent and severer. Some seven or eight years since a freshet of great severity overflowed the meadows, depositing a large amount of sand and gravel, and, I am told, effectually blocking up the ditches, and that they still remain unopened. There is no trouble from the river, as the current is sufficiently active. I would add that there has been less fever, whether of the intermittent or remittent type, the last year in the Konkapot district, than in any one of the several years before. Aside from the Konkapot district, I am at a loss to account for the malarial cause. Even in that district, until quite recently, intermittent has long been unknown. Except in quite the north part of this town, there have been more cases of remitting fever than usual, for the last three months; but there are a less number of cases now than there were in the month of June, which is usually quite a healthy month."

The second letter is dated Jan. 17, 1881.

"The last year (1880) there has been but very little intermittent fever in New Marlborough. I cannot call to mind more than three or four cases that have occurred in my practice during the year. From about the middle of May to the middle of October, I had twenty-eight cases of bilious remitting fever. It has been quite healthy with us since that time: I have had but two cases of fever, but both were severe and protracted. It would seem, from present indications, that the intermittent type is disposed to leave us, or to give way to the bilious remittent. It is certain that, in those parts of the town where, for three or four years previous to 1880, we had the greatest number of cases, we now have scarcely any. I would add that the type has been mostly the tertian: there have been no fatal cases. There have been, among the bilious remittent cases, none that have proved fatal."

Monterey. — Dr. E. B. Brodhead reports two cases of intermittent fever in the fall of 1880. He has known of none previously. One of the cases was near Monterey reservoir, the other on low lands of Lake Buell.

Otis. — Dr. C. B. King makes the following statement: —

"Three-fourths of the cases of sickness in town are of malarial type, mostly remittent, a few cases of typho-malarial. One case of intermittent just developed (August, 1880). No fatal cases during the past year, though several deaths from typho-malarial fever during the past nine

years. No season is exempt with us. One fatal case last year of typho-malarial in the middle of winter, one in early fall; in fact, we are not free from it during any part of the year. Otis is renowned for its ponds and reservoirs, and none of us live far enough away from all to be safe from their influence. I doubt if any more cases are developed in the neighborhood of the Otis reservoir than in other parts of the town."

Great Barrington. — Dr. Samuel Camp reports fifty cases of intermittent fever, of quotidian and tertian type, during the past year, and writes concerning them, as follows: —

"Malarial fever of the tertian form has prevailed very extensively in the town of Sheffield, which joins this town upon the south, for the past three years; but very few cases have occurred in this town up to 1879, and these wholly confined to the extreme southern portion, bordering upon Sheffield Swamps; but there is much less this year than years previous. It commenced here in June, and still continues (August, 1880), but not as many new cases for the past two or three weeks. All of the cases which have occurred in this town, except in the southern portion, as above referred to, have occurred in the immediate vicinity of the Berkshire Woollen Company's dam, upon both sides, up as far as it is settled. This dam has been standing some forty years. In dry weather, during the summer months, it is drawn down every day, exposing the banks to the sun's rays ; and many times it does not fill again before the next morning."

Dr. W. H. Parks says of his cases, —

"Eight were intermittent, and two typho-malarial. All but one resided near the river, which had overflowed from the dam of Berkshire Woollen Company. They had been at work in a swamp, and drinking freely of its water. The Housatonic River flows through the town: there are swamps, etc.; but I have never known of the existence of intermittent fever before. A few years ago an epidemic of diphtheria occurred, and was very fatal, in the same locality now most affected."

Stockbridge. — A single case of tertian intermittent is reported by Dr. L. Miller, as occurring in June, 1880, the first within his knowledge. This case was in a house situated fifty rods east of the Housatonic River, and near the meadow through which it flows. The patient was an old and feeble man. Dr. Miller states that cases occurred ten or a dozen years ago in the practice of the late Dr. L. S. Adams.

Lee. — Dr. C. C. Holcombe reports twenty-five cases of intermittent and typho-malarial fevers. The type is quotidian and tertian. The cases occurred in the summer, "in

most cases near some pond or swamp, within a few rods generally; a few exceptions to this rule." He believes the disease has not been known for the last fifty years; and he has never seen a case here until the past year. Two of the cases were in the village of Lee, a few in the east part of the town, and the remainder at Lenox Furnace and between the Valley Mill and New Lenox.

Dr. D. M. Wilcox reports two cases of tertian intermittent at Lenox Furnace, occurring in the summer of 1880. These were within fifty and a hundred and fifty yards of the Housatonic River respectively, with a reservoir above and below: that below, small, and without any marshy surroundings; that above, five hundred yards distant, extensive, and with surrounding swamps.

Dr. E. Wright reports that he has had fifteen cases the past year at Lenox Furnace and vicinity, but furnishes no details.

Dr. C. E. Heath has had, during the summer and autumn of 1880, six cases of tertian intermittent. Two of these were at Lee, one at Lenox Furnace, and one at New Lenox. The locality of the others is not stated.

Of the cases reported by these physicians, it appears that but very few were in Lee, nearly all being at Lenox Furnace and New Lenox, both of which villages are in the town of Lenox, though close to the Lee line: some of them are therefore included in the report from Lenox. The village of Lee lies in a bend of the Housatonic, close to its border. There is a dam at the north part of the village, but no marshy borders. Lenox Furnace is also upon the Housatonic, and a dam and mill-pond of small extent are there situated.

Lenox. — This town is mostly high and hilly, but on its eastern border is the valley of the Housatonic. For a distance of about three miles, the river forms the boundary between Lenox and Lee. North of this portion it is wholly in the town of Lenox. The valley is narrow, the river running close to the foot of the "East Mountains," or Hoosac range, and the land upon the west rising less abruptly to the elevation upon which is situated the village of Lenox. The valley is less than a mile in width at the northern part, and much narrower toward the south. New Lenox and

Lenox Furnace lie in this valley, being in the north-east and south-east corners of the town, respectively. The village of Lenox is two miles west of the river, and about two hundred feet higher. At Lenox Furnace is a small mill-pond. A mile above this is the dam of the Smith Paper Company, furnishing water-power to their "Valley Mill." This dam is between seven and eight feet in height. Ten years ago it was raised three or four feet, bringing it to its present height; and so slight is the fall at this place that the water was set back to the Pittsfield line, — a distance of four miles in a direct line.

In the vicinity of this portion of the river, intermittent fever has prevailed since the summer of 1878; and there is no record of its having ever existed here before. The cases have been under the care of several physicians: but Dr. R. C. Greenleaf of Lenox has made a careful examination, and finds that the number of cases in 1878 was twenty, in 1879 sixteen, and in 1880 fifty-four; making a total of ninety cases. The cases in the summer and fall of 1878 were in houses situated from three to three and a half miles above the dam; and, with one exception on the east side of the river, most of them were from an eighth to a quarter of a mile from the river at the foot of the mountains. Two of the cases were nearly three-quarters of a mile from the river, up the mountain-side, in gorges formed by two small streams which here flow into the Housatonic. One case was in a house about twenty rods west of the river. In 1879 the cases occurred in the latter part of the season, and were nearly all on the east side of the river, from a mile and a half to four miles above the dam, along the foot and a short distance up the side of the mountains. In 1880 the attacks began in April, and cases continued to appear until August, after which there were few new cases, — perhaps for the reason that nearly the whole population had then been sick, and that all, whether sick or well, took quinine freely. The cases in 1880 were partly in the same neighborhood, on the east side of the river, as in 1878 and 1879; and many also appeared on the west side of the river, on a road running nearly parallel with the river, and from half a mile to a mile distant. In this latter locality, however, it was found that the greater number were men or boys who had fished on the

river at night. Three cases were in a house at Lenox Station, close to the west side of the mill-pond, eighty rods above the dam.

During the three years, cases of intermittent fever occurred in every one of the twenty houses situated on the east side of the river, between the dam and the Pittsfield line, — a distance of four miles; and cases also occurred in twenty-two houses on the west side, being more than half the houses within a mile of the river on that side. Two of the houses, one on the east and one on the west side, were just over the Pittsfield line. In these, three cases occurred.

This malarious district is exactly co-extensive with that portion of the river which forms the reservoir for the valley mill. This reservoir is four miles in length, and generally but a few rods in width, as the river runs through a meadow from a quarter to half a mile in width. Immediately above the dam, however, the reservoir widens out for a short distance, to a breadth of over a quarter of a mile. Throughout the summer and fall, this wider portion is uncovered, the bottom covered with black mud, from which rise the black and rotting remains of stumps and bushes. The borders of the river, also, are bare and muddy, the grass and bushes being killed by the daily rise and fall of the water, which keeps the borders of the river, and the tongues of land formed by the sharp curves, in a soggy and "drowned" condition. In the early morning and on Sundays, when, the gates being closed, the water accumulates, these marshy borders are more or less covered with water; but every working-day they become denuded.

The upper extremity of this reservoir is four miles below the point where the sewage of Pittsfield enters the river. Since, in the local discussion of the probable cause of this malarious outbreak, the contamination of the river by sewage was mentioned, the water was analyzed by Professor Wood. For purposes of comparison three samples were taken: one (No. 1) from the West-street bridge in Pittsfield, half a mile *above* where the sewer enters the river; a second (No. 2) from the South-street bridge, half a mile *below* the mouth of the sewer; and a third (No. 3) from the bridge at New Lenox, in the midst of the malarious district, and five miles below the sewer-outlet.

PITTSFIELD

WASHINGTON

LEE

LEE

MAP

OF THE EASTERN PORTION OF

LENOX

COMPILED FROM BEERS COUNTY ATLAS

SCALE 160 RODS TO 1 INCH

W.A. FISH PUB. ENG. BOSTON.

	No. 1.	No. 2.	No. 3.
Ammonia	.0013	.0016	.0088
Albuminoid ammonia . . .	.0192	.0200	.0188
Chlorine	.18	.30	.22
Fixed residue	9.30	10.	10.60
Volatile residue	3.50	2.50	4.80
Total residue	12.80	12 50	15.40
Hardness	7½°	7½°	8°

This analysis shows that the water at New Lenox contains more ammonia than either of the Pittsfield samples; but the proportion of albuminoid ammonia is less than either just below or just above the sewer. The chlorine is decidedly less than in No. 2, though somewhat more than in No. 1. The water is therefore much purer than at Pittsfield below the sewer, and not very different from the water above that point, being even purer as regards albuminoid ammonia.

The accompanying map of the eastern portion of Lenox shows the whole of the region where cases of intermittent fever have occurred. The black squares show the location of houses where cases have appeared, the dates indicate in what years the cases have occurred, and the figures under the dates show the number of cases in each year.

West Stockbridge. — Dr. W. W. Leavitt reports that he has practised in West Stockbridge for eighteen years, and never knew a case of intermittent fever there of local origin until September and October, 1880, when he treated six cases. One of these was in the village of West Stockbridge, to which he is unable to assign any local cause; two at State Line, close to swampy land; and three in Richmond, near the reservoir. These were all well-marked cases of tertian ague, and all yielded promptly to treatment.

Richmond. — Dr. S. M. Reynolds reports two cases of tertian intermittent, and two of remittent fever, occurring in the fall of 1879 and summer of 1880. All occurred near wet or swampy land; some of them near the Richmond

reservoir, on the northern border of the town. In addition to this reservoir, Dr. Reynolds says, "We have plenty of swamps and wet lands: when they are covered with water, these seem to be all right; but when they dry up they smell very badly, and I notice that more sickness follows soon." He further states, that he had a few cases of malarial fever eight years ago, but none since till 1879.

Pittsfield. — Three cases of intermittent fever are reported in the south-east portion of the town, close to the New Lenox line, and included in the report of that locality; and a fourth in the south-western portion at Barkerville, close to the Richmond reservoir, is reported by Dr. Mercer. These were all in the summer and fall of 1880. A few other cases of fever of a more or less periodic character are reported in various parts of the town, but none of them distinctly marked. Dr. Roberts has had two cases of typhoid-fever, in which chills occurred every second day. Dr. Allen has had two cases of diarrhœa in one house, accompanied with chills; and Dr. Bailey reports two cases in which chills occurred irregularly, without other marked symptoms. Of the two last, one had been exposed to the night air of the river. For the others no local cause could be assigned. The malarial character of all except the four first mentioned, although possible, must be considered doubtful. The town has been remarkably free from typhoid-fever for several years past; and the summer of 1880, though unusually hot and dry, was a healthy one. The town contains two large reservoirs in the northern and western portion, which become low in summer, exposing a large surface covered with decaying stumps. These were unusually low the past season, but no cases of chills and fever are known to have occurred in their vicinity. The village is built on a high, dry table-land, between the two head-waters of the Housatonic River, on the banks of which, on a lower level, the factory villages are situated. Intermittent fever has been unknown in Pittsfield previous to 1880, and probably no cases have occurred since those reported by Dr. Childs in 1836.

Lanesborough. — In the village of Berkshire, in the eastern part of this town, Dr. Thayer of Cheshire reports that he had fourteen cases of intermittent fever in 1879, of which five were imported; and twenty-six in 1880, nearly all indi-

genous. The cases in 1879 occurred after Sept. 1; and those in 1880 in July, August, and September. They were mild, and mostly of the quotidian type. All the persons affected lived within a few rods of the margin of the Cheshire reservoir, at its southern extremity. A large portion of this reservoir was formerly forest; and when the water is low, in the summer and fall, an immense area of the bottom is exposed to the air, covered with rotting stumps and other vegetable matter. The raising of the dam a few years ago greatly enlarged the area of this reservoir, which is fed by several small streams, and forms the source of the Hoosick River.

Cheshire. — Dr. Thayer reports one case of intermittent fever in 1879, and three in 1880; all in close proximity to the northern extremity of the Cheshire reservoir.

North Adams. — Intermittent fever has been unknown in this town until 1880, when thirteen cases are reported, seven by Dr. Brown, and six by Dr. Millard. The prevailing type was tertian. They all occurred within village limits. The town is situated upon the Hoosick River, and is well drained with the exception of the southern portion, which is low and swampy, and without drainage. This defect is now in the way to be remedied. Typhoid-fever is said to have been much less prevalent during the past ten years than formerly. Cases of bilious-remittent and typho-malarial fever are reported to have occurred the past year, though to what extent is not stated.

Williamstown. — No cases are reported from this town. In November, 1878, however, a paper was read by Dr. E. E. Mather of Williamstown, before the North Berkshire Medical Society, in which he called attention to the diminished prevalence of typhoid-fever of late years, and of the substitution for it of a milder form, having the characteristics of remittent fever. In August last he wrote, "I have not seen the fever to any extent since."

Hampden County

Longmeadow. — Dr. T. L. Chapman reports that cases of intermittent first appeared in March, 1880, and that twenty cases have occurred during the year. Six were previous to Aug. 1, the remainder since that date. Type, tertian.

The cases occurred on high and dry land, some distance from the river. There are no reservoirs nor swamp-lands in the town.

Agawam.—Dr. E. G. Ufford reports that the first cases occurred in 1878. They were two in number, both near a sluggish brook, and were the first cases known in the town for many years. The number of cases in 1880 was fifty or sixty: some were severe, but the cases were generally mild. All but half a dozen have occurred since Aug. 1. Several of the cases were imported. As to locality, "most of them were in the eastern part of the town, bounded by the Connecticut River, some back on the plain, and some in the very western part, near the Mount Holyoke range. It appeared more like a general epidemic than from any local state to be found; and it progressed more and more through September and October, and then suddenly ceased."

Springfield.—Communications received from ten physicians of Springfield indicate a general prevalence of intermittent and other forms of malarial fever in that city. The date of its first appearance is variously stated at from two to ten years ago. Four place it at ten years ago, say 1870; three say five years ago (1875); one says three or four years; one, three years; and two, two years. The number of cases during the year ending Aug. 1, 1880, reported by ten physicians, was one hundred and twenty-four, including various forms of malarial fever. The number of cases of intermittent fever in the whole city during the year 1880 has been estimated by Dr. P. LeB. Stickney at two hundred and fifty.

The following letters from Dr. Stickney are so full and valuable that they are given entire. The first is dated Aug. 12, 1880.

"Number of cases of pure intermittent fever from July, 1879, to Aug. 12, 1880, twelve; prevailing type, tertian. Also cases of remittent and typho-malarial fever, one of the latter fatal. In 1879 the first case occurred in May; the other cases during the summer and fall months. In 1880 the first case was in July. All the cases resided near the Connecticut River, and on both sides. The worst case of pure intermittent was ten rods from the bank of the river, on the west side.

"The first cases which came under my observation occurred more than ten years ago. One of these cases had been living at the West twenty years previously; one had not been exposed to such influences. Remittent fever, which I have always regarded as the result of malarial

influence, has prevailed here to a greater or less extent during my whole period of practice of thirty-five years, commencing in 1845. This form of fever was always termed 'bilious remittent,' and often only 'bilious.' One of the oldest physicians living on the west side of the river informed me that he had often seen it ushered in with 'distinct chills,' and sometimes they would recur during the 'run of the fever, like fever and ague.' Most of these cases occurred during the months of July, August, and September of each year; some of them as early as the latter part of May and June.

"In this city there is a very good though not a very extensive system of sewerage. The principal streets have sewers running through them, which drain the surface-water of adjoining streets. On these principal streets, and where it is conveniently near, all the house-drains, water-closets, etc., are drained into them.

"From what I have been able to learn from a few of the oldest inhabitants years ago, I am satisfied that 'malarial fever' in some of its forms has always prevailed here. Typhoid-fever has also been of frequent occurrence; and from the want, as I think, of a careful discrimination, and from the opinion that malarial fever was well-nigh impossible in this long-settled part of the State, the forms of fever that have occurred during the summer and fall months have *all* been regarded as typhoid. To a close observer of the facts, it is evident that while the number of cases of a malarial type have been few in comparison with those of a typhoid character, yet that there have been quite a large number of cases of the former is sufficient to make good my statement. It has been a common observation and remark among the older practitioners for a few years back, 'How few comparatively have been the cases of typhoid-fever, and generally how easily managed.' It is also a fact that during this past period, while typhoid has diminished in frequency, this malarial form has steadily increased, until now it is well-nigh epidemical. So far as I have been able to ascertain, there is no well-authenticated medical record of this region. What I have been able to learn has been mostly of a 'hearsay' character. Perhaps a more thorough investigation may reveal something more definite and trustworthy.

"In 1838 Dr. O. W. Holmes wrote a prize essay on 'Intermittent Fever' in this State. In that excellent and exhaustive essay, a full account of the prevalence of this form of malarial fever in all parts of the State may be found. As regards this particular region, there is nothing said in the essay; but as to Northampton, Deerfield, etc., the account is more full. But inasmuch as the similarity of soil, the rivers, brooks, the annual overflows, the swamps, low lands, boggy meadows, dams, etc., are so nearly alike, and where the same local influences would naturally produce like results, there can hardly be a doubt but that this form of malarial fever, together with its remittent type, prevailed here as well as ten to forty miles to the north in localities similarly situated. Of course to the younger practitioners this outbreak of malarial fever is inexplicable, and difficult to understand: since so long a period has passed since the early settlement of the region, with its improvements in draining, cultivation of soil, redemption of low lands and swamps, it has been

regarded 'impossible for malarial fever to prevail, that its influence was of no account, for it did not exist.' From my own observation over this long period of years, I believe it is indigenous. Why it should remain in abeyance and quiet for so many years, and then break out with such force, is because it is indigenous; and when certain unknown causes are operating it makes itself manifest, simply waiting for these causes to operate."

Dr. Stickney's second letter is dated Feb. 10, 1881. He says, —

"I have delayed answering your note, in order to ascertain, as far as I could, the number of cases of intermittent fever that have occurred during the past year (1880). I brought the subject up at the meeting of the Medical Club; and as far as could be known, judging from the cases which had occurred in the practice of the gentlemen present, there could not have been less than two hundred and fifty cases. Some of the members estimated it even higher than this number, — at three hundred cases. It has been very difficult to get at a perfectly true estimate, inasmuch as a great many cases obtained their medical treatment of the druggists; and then, when a number in the same neighborhood were affected, one of them would get a prescription, and 'hand it round' for the general benefit: so that you see at once that it is impossible to get at more than a comparative estimate of the number of cases. As to the different localities, there have not been any exceptions: it has been universal. Perhaps there may have been one or two neighborhoods where there were a few more cases, near the lower or southern portion of the city, in the immediate vicinity of two large brick-yards, and near a large brook; so, also, along the banks of the river. With these exceptions (and they are hardly such), people living in all sections have been affected by this malarial outburst. The well-to-do, the poor, and the rich have been the subjects of this disease. Those living in the lower and those in the higher districts have all alike suffered. What is somewhat singular, and has been unusual in my experience with this disease (both in my own person and in the treatment of it in others), its influence is still prevalent. Notwithstanding the unusually severe cold which has generally heretofore destroyed it, it still makes its appearance; and especially those who have been its subjects occasionally have a new attack, with all its original energy. Its influence is more or less exhibited in other forms of disease. In some cases of influenza, pneumonia, and rheumatism, there have been chills, more or less severe, together with the peculiar gastric disturbance, and requiring a modified treatment. Quinine, to be sure, is getting to be a very fashionable remedy; but, nevertheless, we cannot get along without its use in nearly all cases of sickness."

Dr. S. W. Bowles reported, in July, 1880, that he had treated thirty cases of intermittent and remittent fever, generally of tertian type, during the year past; that he first saw it five years ago, since which time it has steadily in-

creased in frequency each year, and that it has not been limited to wet localities.

Dr. S. D. Brooks reported, at the same time, that he had attended several cases in the south-east part of West Springfield, also in different localities in Springfield. Of ten well-marked cases, eight were intermittent, one remittent, and one typho-malarial. The type in one was tertian, and in nine quotidian. The large majority occurred in low, damp localities, in the midst of meadow-lands, and on comparatively newly-made streets. The disease has increased from year to year for the past five years. Most forms of disease take on a remittent character, more than formerly, showing the presence of malarial poison.

Dr. G. C. McClean reported, Aug. 10, 1880, that he had treated ten cases of intermittent fever of quotidian and tertian type during the past year. He had known the disease to exist in Springfield for ten years; but the number of cases had increased largely within three years. Most of the cases have occurred on the low ground within one-half mile of the Connecticut.

Another physician (who inadvertently omitted to sign his report) stated that he has, in years past, treated several cases among the employés of the several brick-yards in the city, and which were evidently caused by their constant working in the damp, cold clay. The origin of the malaria could not be accounted for in any other way. The majority of his cases have lived on the east side of the Connecticut River, and within one-eighth to one-quarter of a mile from it. He cannot say when it first appeared; but it has been steadily on the increase for the past ten or twelve years, more especially during the past six years.

Two other physicians state that their cases have been generally from one-eighth to one-half mile from the river.

West Springfield. — Dr. U. H. Flagg reports, Feb. 1, 1881, that he has treated over one hundred cases of intermittent fever in 1880, and that physicians of Springfield and Chicopee have treated as many more. He says, —

"The disease has prevailed on the low lands. Those who have worked down there, and lived on the higher ground, have had it, and their families have escaped entirely. School-children, living on high ground, and attending school on the lower level, have contracted it. A

strip of land, three-quarters of a mile wide, adjoining the Connecticut River, seems to have been nearly its entire range in this town. These low lands are protected from the Connecticut River by dikes."

He adds that the disease was scarcely known previous to 1879.

Chicopee. — Dr. D. H. Nutting reports that the whole number of cases of intermittent fever in Chicopee, in 1880, may have been three hundred. Cases have occurred for the past three or four years, though the number has been small until the past year. The cases were located "near the rivers and around the ponds, caused by the dams built across the Chicopee River for manufacturing purposes. Some of my worst cases were in houses near the junction of the Chicopee and Connecticut Rivers, and where the main sewer of the lower village empties into the river. As some of the mills were run night and day, and there was little rain, the water was reduced to a low point."

Dr. H. G. Forbes reports that he has not known the disease to originate in Chicopee previous to 1879. Most of his cases "contracted the fever while living on the low lands along the river, in tenements belonging to the cotton-mills. At that time (1879) the streets were being sewered; and the digging in the low, wet grounds may have produced it."

Holyoke. — Dr. J. J. O'Connor reported in August, 1880, that he had treated more than fifty cases of the various forms of malarial fever during the past year. The general type was quotidian. The disease "first made its appearance three or four years ago at Ashley Pond, whence we derive our water-supply. All the families in that vicinity were affected. That was in the spring of 1875, and ever since we have had it. Many of our cases have resided in the vicinity of our canals and along the river-bank."

In March, 1881, Dr. O'Connor reported that the number of cases in Holyoke during 1880 was about five hundred.

Dr. C. Blodgett reports that his cases have been, the majority of them, in the vicinity of Ashley Pond. The distance varies from the immediate vicinity to a mile. The remainder of the cases resided about the city and South Hadley Falls. He states that the dam at Ashley Pond was raised two or three years ago.

"All the swamp-lands lie about Ashley Pond. This locality is the only place in this vicinity apparently favorable for the development of malarial poison. I do not think the cause of malaria is limited to the pond, because the conditions above and below Holyoke for miles produce malarial disease. These conditions apparently have not been modified for twenty years."

Ludlow. — A physician of this town reports no indigenous cases, but has treated four cases of intermittent fever during the past year (to Aug. 1, 1880), contracted, two of them in West Springfield, and two in New York or New Jersey. He says that the town contains considerable swamp-land, a number of ponds, and a large reservoir, the source of Springfield's water-supply, but that no cases have occurred in the vicinity of any of these.

Southwick. — Dr. J. W. Rockwell states that intermittent fever first appeared in this town in June, 1880; and that eight cases of tertian type occurred during June, July, August, and September. "None of the cases were near water or swamps, but on rather high land, with a sandy, loam soil. One case was in the north part of the town, two at the centre, and five in the south-east part."

Brimfield. — Dr. G. F. Chamberlain reports that intermittent fever first appeared in 1879, and that half a dozen cases have occurred during the past year. These were generally of tertian type, and occurred "mostly in winter." The persons affected lived "on high land; but the locality is wet and somewhat swampy, though no ponds or rivers are near."

Hampshire County.

South Hadley. — Dr. H. A. Deane reports that intermittent fever first appeared in the spring of 1880. Up to Aug. 1 he had treated but one case, and four cases of remittent fever. The patients resided "on the westerly side of a mill-stream, distant from five to forty rods." Another physician had, up to the same date, treated three cases of intermittent residing "widely apart, some on high and dry ground, none very near reservoirs, etc." Dr. Deane writes, Feb. 1, 1881, that he "should say there were over fifty cases of intermittent fever in South Hadley since Aug. 1, 1880. Most, or fully half, were at Pearl City, on a water-course draining large swale-lands."

Northampton. — Dr. C. L. Knowlton reports that he first met with cases in 1879. During the year ending Aug. 1, 1880, he had treated seven cases, all quotidian, residing "on the west side of the Connecticut River, at a distance of from a quarter of a mile to a mile." After this date the number of cases greatly increased.

Dr. C. Seymour wrote as follows, Sept. 27, 1880: —

"The first cases I ever saw were last summer (1879), and only a few. This year to date there have occurred in this town, by careful estimate, full one hundred well-marked cases of intermittent fever. Most of these have been near the streams of water, though a few have occurred on high ground. It is safe to say that the dampness arising from the valleys through which brooks run, however small, promotes the disease. A very large percentage of the cases have occurred at 'Mount Tom,' a railroad-station on the Connecticut River Railroad, two miles below our village. Here is located a large sawmill, employing seventy-five men; and these have quite generally suffered. Many of them have never consulted a physician, as they know quinine cures the 'shakes,' and get and use it accordingly. Hence many cases have occurred here, undoubtedly, not enumerated in my list. The 'cause' of malaria in this vicinity is extremely obscure. Low water in the Connecticut River cannot account for it: that has been low many times before. It is a fact that malarial diseases have been creeping up the Connecticut Valley from Saybrook for many years, and that is the only fact we have thus far concerning it. Imperfect drainage does not seem to favor it. In this town we are almost entirely without sewerage; and yet, paradoxical as it may seem, our filthiest localities have thus far escaped malarial infection. Typhoid-fever holds them against the new intruder. The adjoining towns of Hatfield and Hadley are suffering more from the disease than we are here, probably because they lie lower and closer to the river."

Easthampton. — Dr. J. W. Winslow reported Aug. 23, 1880, that cases of intermittent fever first appeared the last of July, 1880. He had then seen ten cases, all in the immediate vicinity of two large artificial reservoirs, used for manufacturing purposes, three-quarters of a mile apart. Writing again Feb. 1, 1881, Dr. Winslow says that the number of cases in his own practice during the past year has been twenty-five or thirty. He adds, —

"This invasion of intermittent fever occurred about the time of my first report, and did not confine itself to the location mentioned, but appeared in other and distant parts of the town. It is not known to have been epidemic in this town at any previous time. Reservoirs and streams have been unusually low."

Dr. F. C. Greene reported in August last that he had seen five cases of remittent fever in July, 1880, "near the Connecticut River at Mount Tom, near that standing piece of water called the 'old bed.'"

Hadley. — Dr. Franklin Bonney reports that intermittent fever first appeared in August, 1879, when he had one case. There were no more cases until July, 1880. Dr. Bonney wrote in August that he had then treated sixteen cases.

"All but two of the cases reside near a mill-pond or upon the river that feeds it, in a north-westerly direction, most of them within fifty rods, the balance of them not more than one hundred rods. The two exceptions live upon the east bank of the Connecticut River, with flats not far off, say fifty to one hundred rods. These persons reside four miles apart. The pond has existed for two hundred or more years, and is formed by a dam built for the purpose of running a grist and saw mill. The proprietor of the pond informs me that the water has been unusually low during the past season."

In a second communication, dated Feb. 1, 1881, Dr. Bonney states that the number of cases of intermittent fever in Hadley in 1880 was about one hundred. The cases occurred "near two mill-ponds, in which the water was very low for many months. Several of the individuals suffering have had a recurrence of the chills within a few weeks after exposure to cold."

Hatfield. — Dr. Barton reported in August, 1880, that the first case in that town occurred in July, 1879, and a few cases followed during that year. Cases again began to appear in July, 1880; and at the time of the report he had treated or was treating twenty cases of intermittent and seventeen of remittent fever.

"The distinctly intermittent cases are nearly all tertian. Seventeen cases were quotidian; but in most or all of these the fever was continuous, having a moderate daily remission. Two-thirds of the cases live on a stretch of low ground extending three miles north and south, and one-half mile east and west, through which runs a brook. The land has been cultivated for twenty years. A railroad is now opening through it, but cases appeared before the work was commenced. The only reservoir is three miles away, and people near it have not been affected, with one exception."

Amherst. — Dr. D. B. N. Fish sends the following letter dated Aug. 23, 1880: —

"There has been in this vicinity, and especially in North Hadley, along the Connecticut River, a tendency to periodicity, apparently of malarial origin, in various diseases for several years, and there have been many cases of intermittent and some of remittent fever; but until this present month of August I have seen no cases that might not have originated elsewhere. I have seen this year (1880) eleven cases of intermittent fever: of these, six cases occurred in parties who have had malarial fever elsewhere; one was the first attack, but the party had lived in a malarial district; two may possibly have originated elsewhere; but the remaining two certainly originated here. In brief, two cases of intermittent fever have originated in North Hadley, two and a half miles north-west of Amherst Centre; one in North Amherst, three miles north, probably originated there; and one in Old Hadley, two and a half miles south-west, was almost certainly acquired there. All intermittent, type tertian; one quotidian. None fatal. All the indigenous cases in August.

"L. M. D., aged fifty-eight, at North Amherst, has worked for weeks in a cabbage-field where the stumps and leaves of cabbage left after cutting lie rotting in the sun, and give out an offensive odor. This man has been in Holyoke two or three times a week, but only in the early hours of the afternoon, and I think acquired the disease at North Amherst.

"Mrs. E. S. Moore of Old Hadley lives on dry, sandy soil, with low marshy ground to the east. She has spent a few days in Montgomery, Mass. I think that she acquired the disease in Hadley.

"John Collins, twelve, and Mrs. James Powers of North Hadley, who have never been in a malarial district, and have not been from home for years, live one-eighth of a mile from and to the east of the head of North Hadley Pond, which is and has been unusually low. The boy has frequently bathed in the pond. This North Hadley Pond, or natural reservoir, is owned, I believe, by George C. Smith of North Hadley, and has been in use for a great many years. No cases believed to be indigenous till the present month. Have not known of any cases in adjacent towns previous to this year. No preventive measures taken. Low, wet lands receiving the sewage, in the centre of the town, with no system of sewerage, and the several ponds at the ends of the town, furnish conditions favorable for development of malaria.

"Aug. 27, 1880. — Two more cases of intermittent fever, tertian, at North Hadley, near the lower end of the *pond*. Parties have never lived elsewhere."

Dr. Fish writes again, Feb. 18, 1881, as follows: —

"I can learn of only five cases of intermittent fever of local origin in Amherst during 1880, — two in the Centre, one at North Amherst, and two at South Amherst. In none of these were the surroundings such as to suggest malaria, unless in the case at North Amherst already reported. In North Hadley sixteen cases have come under my care, and I have known of seven others, all of which have been reported to Dr. Bonney.

Of these, fourteen were near the North Hadley Pond, seven near the Connecticut River, one near a small pond south of Mount Warner, and one in a dry, sandy location, with no local cause apparent.

"There have been many other cases in Amherst and North Hadley, not reported because of the possibility of other than local origin.

"We have been getting in town for some two years a malarial element in disease, as shown by the greatly increased frequency of hepatic derangements; and I believe this malaria has come to *stay*, for some years at least. I find that these cases of intermittent fever of local origin require much more vigorous treatment for their relief than was formerly necessary for the imported cases, because, as I believe, of continuous influence of malarial poisoning. The theory has been advanced, that the malaria that has been creeping up along the line of the Connecticut is due to low water in the river; in some cases it has been attributed to defective sewerage: while I must admit that these causes would increase the liability to the disease, yet I think there is a cause back of and entirely independent of them.

"The North Hadley Pond has been as low many times in past years, and around it has raged many an epidemic of typhoid-fever, but this is the first time that malarial fever has appeared there. Barring these cases of intermittent fever, North Hadley has been remarkably free from disease for the past six or eight months.

"I spoke, in my letter of Aug. 23, of the park in the centre of this town being utilized as a cesspool. We have now a good sewer which does away with the nuisance.

"Dr. Bigelow tells me he has had one case of intermittent this month, of local origin, near the Centre, with no malarial surroundings. I have seen no new cases since October."

Southampton. — Dr. H. P. Atherton reported in August, 1880, that he had seen five cases of quotidian intermittent fever during the spring and summer, near Westfield Pond, commonly known as "Hamden Pond." The disease had been previously unknown in Southampton.

Cummington. — A physician of this town reports that one case of tertian intermittent fever occurred last summer, distant from any swamp, pond, or reservoir, but in a house having a wet, unventilated, and undrained cellar. He mentions also a case occurring two years ago, on the grounds of L. L. Brown & Co.'s paper-manufactory. No other cases have appeared of indigenous origin. The town, he says, has no extensive swamps, but in the West Cummington village are several artificial ponds.

Huntington. — Dr. J. N. Dickson reports as follows: —

"Two well-marked cases came under my notice a year ago; chills followed by fever, etc., at first every day, later every second day. They did

not wholly yield to treatment until patients were out of town for a month. Cause, stagnant (or nearly so) water in the immediate rear of the house; a very gravelly soil made cellar unusually damp, which had to do with the obstinacy of the cases. The overflow of a spring kept this water from wholly evaporating, but was not enough to cause it to flow freely. Where this water stood was washed out by the flood of December, 1878. Filling this has kept the trouble away so far this season."

Franklin County.

Sunderland. — Dr. C. G. Trow reports two cases in that town, in 1880, the first that have been known. Concerning one of these cases he wrote thus, Aug. 30, 1880: —

"I have been unable to find any trace of a case of local origin that has ever occurred in the town, unless one that has come under my notice during the present month be such a one. This was a case of the tertian type, occurring in the northern part of the town. The patient, a lady, has lived on the same spot for years. The house is situated about ten rods from the Connecticut River, and perhaps thirty feet above, and fronts on the river. A short distance in the rear of the house is a ledge, and above and behind this a mill-pond flowing about four acres. This pond is situated about fifty feet above the house, and is some thirty rods distant from it. The lady spent a short time in Meriden, Conn., last fall; and it seems to me the probabilities are, that she contracted the disease there, rather than at home."

Dr. Trow writes, Feb. 1, 1881, that he has since seen one other case in Sunderland, and says, —

"The two cases were between the river and a belt of land composed of rather heavy soil, about two feet in depth, covering a bed of decaying leaves, logs, etc., from four to eight feet deep, — a buried swamp."

Whately. — Dr. Trow reports that he saw a single case in the north-eastern corner of this town, in August, 1880, and has seen no other case since, although he thinks there were a few in another portion of the town. He says, —

"This case came under my notice Aug. 26. I saw the patient after the fifth paroxysm. The disease was a well-marked case of the quotidian type, and was, I think, without question contracted on the spot. The lady had been in no place where she could have been exposed to malaria, except that she went to Westfield, Mass., on the day previous to the first paroxysm, where she remained a few hours. This would give too short a period of incubation. The house in which she resides is situated by the roadside, and about forty rods west of the Connecticut River. Between the house and river, and close to the house, is a swampy strip a few rods wide, running north and south for some distance. I think there can be no question but that this case is of strictly local origin."

Deerfield. — Dr. Trow reports that he has also seen a single case in South Deerfield the past season. This case was indigenous, and no cause for it could be assigned.

Greenfield. — Dr. T. Womersley reported, in August, 1880, that he had seen one case of intermittent fever, of local origin, in April, 1880. This was quotidian, well-marked, but continued only a week. The patient resides on the bank of Green River, the water of which was stagnant in that neighborhood.

Worcester County.

Worcester. — Six physicians of this city report that they have never known cases of malarial fever to originate there. A single case, however, is reported by Dr. Wesley Davis. This was a case of tertian intermittent, occurring in December, 1879.

"The patient, aged about thirty-five, always lived in this vicinity, never in a malarious region; but his place of business was in a building erected upon made land, from filling in an old pond. Residence one-sixth mile distant, upon one of our oldest streets, though not high land."

Athol. — Dr. J. P. Lynde reports that he met with two cases of quotidian intermittent in one family in the summer of 1880; that he has seen a few cases in previous years, and that he first observed the disease eight years ago. The location of the cases is not stated; but he says, "streams and ponds abound in and around our villages."

Westminster. — A physician of this town states that he saw two cases of tertian intermittent in the summer of 1880. One of these cases, he says, "was probably caused by the patient's sleeping in a damp bedroom, the paper of which would at times be mouldy. The cause of the other was unknown."

Hardwick. — Dr. A. M. Orcutt reports that cases of tertian intermittent appeared in the village of Gilbertville in September, 1880, and that five cases occurred during the fall. The locality was near both pond and river; no swamp save what was caused by the water setting back from the dam, which has a very small surface. One of the patients gave Holyoke the credit for her "shakes."

Douglass. — Dr. A. E. Kemp reports one case of intermit-

tent fever in the fall of 1880, the first known in that town. The location was "near a pond."

Royalston. — Dr. H. O. Adams reports twelve cases of "typho-malarial" fever, "taken with high fever, pulse one hundred and twenty to one hundred and thirty; vomiting. After three days, a slight rash on upper extremities. Tongue coated with thick, nasty coating; running from eight to fourteen days. None fatal: occurring in May and June." These cases, it would seem, scarcely belong in the category of malarial fevers.

Middlesex County.

Ayer. — Dr. B. H. Hartwell reports two cases, one of intermittent and one of remittent fever, in the summer and fall of 1879, "both about eight or ten rods north of a swamp and reservoir of a mill." The reservoir was constructed upwards of twenty years ago. No cases had occurred previously.

Wakefield. — Dr. S. W. Abbott reports one case of intermittent fever in the spring of 1880, concerning which he writes as follows: —

"The patient referred to is a clergyman, a man who has done a large amount of unrequited mental work. Has a large family, and hard work to obtain a living. His age is fifty. He lived two or three years at Atlanta, Ga., and subsequently at Aurora, Ill., whence he moved to this town in 1872. At the latter place (Aurora) he had a slight attack of intermittent, though not serious. He has also had an attack of acute rheumatism about twelve or fifteen years since. Last May he was attacked with severe chills of an intermittent type, after being in quite good health for eight years. The fever was at first controlled by quinine, but after a fortnight it recurred, and refused to yield to any sort of treatment; and for nearly four months he has been prostrated by daily recurring febrile attacks, beginning every afternoon at present about one P.M. I have repeatedly given him careful examination, and failed to detect any local lesion, except slight tenderness between left kidney and spleen, which has recently disappeared. He has been seen in consultation by Drs. Bowditch, Cutter, and Dow, all of whom agree in a diagnosis of chronic malarial infection (as described in 'Ziemssen,' vol. ii.). His pulse is rarely below ninety, and often during the paroxysm reaches a hundred and thirty. Temperature not often above 38.5° C. In regard to local causes, it should be stated that in the early spring he often went to church a mile distant in the evening, passing through a few rods of damp, swampy ground, where he complained of heavy dews and an oppression in breathing. I have also noted a tendency to periodicity, and a malarial type, in a few other cases, though not so decided."

Dr. C. Jordan reports five cases of remittent fever in 1879 and 1880, besides ten cases of "typho-malarial," and says he has had cases yearly for twenty years. "Most of the parties reside within one-eighth of a mile of a swamp or pond."

Woburn. — Dr. J. P. Elliott reports "one case which occurred at Woburn, May 16, 1880. A lady who had just returned from Michigan was attacked with chill and rigors for a few hours, and then the hot stage, followed by profuse sweating. I administered quinine; and there were no more attacks until July 12, since which time she has returned West, and has not suffered from it since. She had had no previous attacks. I judge this case to be intermittent in form. The lady was staying within about three rods of the old Middlesex Canal, and west of it. The canal has a small stream of water flowing into it from a small pond of stagnant water. The pond is south of the house, and about four rods distant."

Billerica. — Dr. W. A. Hubbard states that he had five cases which he considered of a malarial character, during the fall and spring of 1879–80. One of these was intermittent, three remittent, and one typho-malarial. "All lived on low ground, near a pond with swampy shores." Dr. Hubbard has resided in Billerica since March, 1877, and states he had, from June, 1877, to June, 1878, three cases of remittent; and from June, 1878, to June, 1879, two cases, one of remittent and one of intermittent fever. As to the topography of the town, he says,—

"Billerica centre is situated on a high hill; but the north, south, and east parts of it abound in ponds and swamps, and low, damp soil. The Concord River flows through a part of the town. This is a very sluggish stream, having very wide, swampy shores. There is also the remains of the old Middlesex Canal, in the town. In the wet season the canal contains a large quantity of water, which, having no outlet, soon becomes stagnant, and remains so until it is evaporated by the hot summer sun."

North Reading. — Dr. William P. Davis reports no cases during the past year, but says that in previous years since 1868 he has had annually from one to three cases of typho-malarial fever. In 1869 he had nine cases. These have been, with one exception, in wet localities. He adds, "My predecessor, Dr. Grosvenor, practised here fifty years. I have heard him say that some years there was a good deal of

'dumb ague.'" No cases of intermittent or remittent fever are reported from this town; and it is most likely that the cases mentioned are of a typhoid, and not malarial, character.

Hudson. — Dr. J. L. Harriman reports no cases of malarial character, but says there were a number of cases in that town in the summer of 1864. No details are given.

Watertown. — Dr. A. Hosmer reports that no cases have occurred in this town of late years; but furnishes the following interesting historical statement: —

"I have heard long since, in a vague, traditional way, that many years ago intermittent fever was original in Watertown. I have never found any means of testing the truth of the statement. Of course now and then I see a case of malarial disease; but, with a single exception soon to be stated, it is all imported. Twenty-five years ago a case of intermittent occurred in the practice of my uncle, the late Dr. Hiram Hosmer. The patient was a man who had never been out of the State, and who lived on the shore of Fresh Pond. The disease was regarded as the product of the place, and the case was considered unique. It is a curious fact, that an attack came just as the patient was getting ready to move to the West."

Essex County.

Amesbury. — Dr. H. G. Leslie reports that he has met with a single case of remittent fever (fatal), in October, 1879. This case was "about one-quarter of a mile from extensive marshes, bordering the Powow River, where a sediment is deposited from the water of factories. Between the village of Amesbury and the Merrimac River are several hundred acres of low marsh-land, through which, in a very tortuous course, washes the Powow River, bearing the scourings and filth of eight large woollen-mills. This natural sink is at times offensive, and without doubt generates disease of all kinds."

Suffolk County.

No cases are reported.

Norfolk County.

No cases reported.

Plymouth County.

Plymouth. — Dr. B. Hubbard reports one case of quotidian intermittent, fatal, in July, 1880. "A stream of water within thirty feet on the south."

Dr. J. B. Brewster states that malarial fevers have not been known in Plymouth during the past year, nor in previous years, to his knowledge.

Bristol County.

Taunton. — Dr. E. J. Bassett reports three cases of quotidian intermittent fever; in the fall of 1879 and spring of 1880. He has seen one or more cases yearly for the past ten years. Of the cases reported, two were not near any water; one was thirty or forty rods from a small pond. Has also seen the disease in Raynham, three or four miles from Taunton. Another physician of Taunton reports three cases of remittent fever. Seven physicians report that they have seen no cases of malarial disease.

Barnstable County.

South Dennis. — Dr. C. M. Hurlbut writes as follows, Jan. 31, 1881: —

"This people are sea-going, 'coasting,' as coastwise trade is called. Therefore I have each summer many cases of intermittent fever. During twenty-eight years of practice in this place, I have had a few cases of indigenous ague. I had it myself eleven years ago last August, which confined me in-doors for ten days. I do not now remember so as to report the cases. Other physicians tell the same. The cranberry interest has been an industry followed by our people for some twenty years past, and the best success is attained by flooding. Whether my own case was the result of this or not, I can't say; but I know I had not left the county for years, except to visit Boston, and I shook every other day, sharp (tertian)."

Summary.

In reviewing the preceding history of intermittent fever, it is evident that the disease is not endemic in Massachusetts, and has never been so for any extended period, with the exception of the town of Sheffield, where it was more or less prevalent from the first settlement of the country until 1832, after which time it was unknown, or nearly so, until 1877. Perhaps Springfield should also be called an exception; since Dr. Stickney believes the malarious influence to be indigenous there, although intermittent fever was almost unheard of until 1870. The disease prevailed in many localities in New England at the time of the first settlement, but soon vanished. Since then it has occurred only in the

form of occasional epidemics. The most remarkable of these, previous to the present one, was between 1793 and 1799. Nearly all of the outbreaks described by Dr. Holmes occurred during this period. Thus either intermittent or remittent fever occurred in Sheffield from 1793 to 1797; Stockbridge and West Stockbridge, in 1795; Pittsfield, about the same time; Northampton, during the few years following 1792; Deerfield, 1793 or 1794; and Hatfield, in 1795. The epidemic at New Milford, Conn., was from 1796 to 1799, though cases of intermittent fever had appeared there previous to 1796. The next period of any general prevalence was between 1828 and 1832, when it appeared in Connecticut, on the Sound, from the New-York line to the Housatonic River. About the same time was a period of increased prevalence in Sheffield; while in 1836, or shortly previous, the disease occurred in Great Barrington, Pittsfield, and Adams. After 1832 the disease was unknown in Connecticut till 1850; and after 1836 it was foreign to Massachusetts until 1870. Counting as the first epidemic the prevalence of the disease among the first settlers, of which we really know but little, the present is the fourth epidemic which has visited New England. It began in New Haven in 1850, remained limited to the vicinity of Long Island Sound till 1864, then began to spread northward, and first appeared in Massachusetts, in the city of Springfield, in 1870. It next appeared at New Marlborough in 1874 (remittent fever is mentioned here as early as 1868); Holyoke, in 1875; Sheffield, in 1877; and Agawam and New Lenox, in 1878. In 1879 it was first observed in Great Barrington, Lanesborough, and Cheshire, in Berkshire County; West Springfield, Chicopee, and Brimfield, in Hampden; and Northampton, Hadley, Hatfield, and Huntington, in Hampshire. In 1880 a few cases appeared in each of the following Berkshire towns: Monterey, Otis, Stockbridge, Lee, West Stockbridge, Richmond, Pittsfield, and North Adams. In Hampden County it appeared in Longmeadow and Southwick; and in Hampshire in South Hadley, Easthampton, Amherst, Southampton, and Cummington. Franklin County had also a slight sprinkling of cases in 1880; five occurring in the four towns of Sunderland, Whately, Deerfield, and Greenfield. Thus we find that there has been a general northward progress, both in Berk-

shire County and in the Connecticut Valley, but not a perfectly regular one; for Springfield, the first place visited in Hampden County, is not the most southerly; Holyoke is not contiguous to Springfield, but followed next in order chronologically; while Longmeadow, the most southerly town, was not invaded till 1880, the very last in order of the river towns in Hampden. In Hampshire County a similar irregularity is observed, — Northampton being reached before Easthampton, and Hadley before South Hadley. In Berkshire County the disease jumped from Sheffield to New Lenox, and thence to Lanesborough, intermediate towns being subsequently affected. In Eastern Massachusetts no special order can be detected, and the cases are so few and scattered as to be of little value in studying the disease. The few cases reported, however, seem to indicate that the causes of malarial fevers are present to a very trifling extent in the eastern part of the State. It is not known that intermittent fever has appeared farther north than Massachusetts. In reply to an inquiry on this subject, Professor H. D. Holton, M.D., of Brattleborough, Vt., writes, Jan. 28, 1881, that intermittent fever has not appeared in Brattleborough, nor, so far as he knows, in any other town in Vermont.

A careful study of the local conditions under which malarial fevers have appeared is indispensable to a proper understanding of this epidemic; and an effort has been made in this investigation, as nearly as possible, to ascertain these conditions. In comparing the evidence from different places, the fact is very striking that these diseases have generally prevailed in the vicinity of water. This was true of the earlier epidemics as well as of the present one. It is also noticeable that the years of greatest prevalence and most extensive spread have been seasons of drought and low water, when rivers and reservoirs have been low, and a large surface of sedimentary mud has been exposed to the sun and air. In Dr. Holmes's essay, the correspondence between the various local epidemics and low water in neighboring streams and ponds is almost uniform. This was found at Sheffield, Great Barrington, West Stockbridge, Pittsfield, Northampton, Deerfield, Greenfield, Plymouth, and Hopkinton, in this State, and at Litchfield, New Milford, and along

the Housatonic Valley, in Connecticut. The same was remarked at Providence and South Kingston in Rhode Island. In fact, in every case in which the surroundings are described, it is found that they were wet or marshy, and that generally the cause of this marshy condition was to be found in the damming of streams to form artificial reservoirs, which become low in summer.

In the recent epidemic, on examining the location of places in Connecticut, of which information has been received, it is found that ten of them are on Long Island Sound, fifteen on the Connecticut River, seven on the Housatonic, five on the Quinnipiac, three on the Farmington, two on Little River, and one each on the Naugatuck, West, Mill, Willimantic, and Hop Rivers. There are but three towns — Bethel, Durham, and New Preston — not situated upon any river; and, as to the local conditions in these, no information has been obtained.

In Massachusetts, fifteen of the towns are on the Connecticut, six on the Housatonic, three on the Hoosick, and one each on the Ware, Nashua, Merrimac, Concord, Saugus, and Taunton. Cases in towns not upon rivers have occurred, with very few exceptions, in the immediate vicinity of ponds, reservoirs, swamps, or some kind of a body of water, with muddy or marshy surroundings. Of the exceptions, the most remarkable is Southwick, where eight cases of intermittent fever are reported, on high land and sandy soil. Brimfield cannot be called an exception; for here, although the land is high, it is described as swampy. Cummington contains several artificial ponds; and yet the one case there reported is attributed by the correspondent to a wet cellar, the locality being at a distance from any pond. That at Worcester was on made land, on the site of an old pond. The surroundings of the two cases at Westminster are not stated. The one at Wakefield lived on high land, but had previously suffered from intermittent fever at the West, and the case cannot with certainty be called indigenous. These exceptions are very insignificant, and, with the exception of Southwick, scarcely worthy of mention. Of the topography of this town no information has been received, except that the cases occurred on high land; but, on referring to the map, the town is found to contain within

its limits a river and large pond, while on either side of it are towns in which the disease had previously appeared.

Of the eighteen towns in Massachusetts reporting more than six cases, twelve are upon the Connecticut River, and comprise all the towns bordering upon that river in the counties of Hampden and Hampshire. The six remaining are in Berkshire, where the surroundings are as follows: at Sheffield the cases occurred near a reservoir which is drawn down in summer, and along the Housatonic River, where stagnant pools, left by the spring overflow, slowly evaporate in the adjacent meadows; at New Marlborough, in the Konkapot valley, where are also stagnant pools formed by the overflow of the river; at Great Barrington, near an artificial reservoir formed by damming the Housatonic River; at New Lenox, close to a reservoir similarly formed; at Lanesborough, on the border of the Cheshire reservoir; and at North Adams on swampy land, near the Hoosick River. In the Connecticut valley, it is generally found that the foci of the largest number of cases are the low lands on the river-banks. At Holyoke, the first cases were near Ashley Pond, a mile and a half west of the river. In several instances it is stated that the first case appeared in wet localities, and that subsequently cases appeared at a distance from such localities. The fact is interesting, that at Springfield, the first, or some of the first, cases are said to have appeared near a brickyard; and that the same was true at North Haven, Conn., and at Nayatt Point, R.I. At Hartford, and several other places in Connecticut, the disease was specially prevalent where extensive digging was in progress, for railroads, sewers, or the grading of streets. In like manner we find that the cases at Hatfield, in this State, were in a meadow through which a railroad was being constructed; and that at Chicopee, in addition to the locality being low, at the confluence of two rivers, sewers were being laid, involving the digging up of the streets.

The summers of 1870, 1876, and 1880 were hot and dry, and all streams and ponds became extremely low. These seasons were characterized by an unusual prevalence and rapid spread of intermittent fever; in 1870 in New Haven and vicinity; in 1876 at Hartford and other towns on the

Connecticut River, in Connecticut; and in 1880 on the Connecticut River in Massachusetts, and certain localities in Berkshire. The low water of 1880 was extraordinary. The Connecticut had not been so low for many years, and all artificial reservoirs became drawn down so as to expose an immense area of marshy bottom.

These were the localities to which intermittent fever was almost wholly limited.

Cause of Malarial Fevers.

The facts deduced by this investigation indicate very strongly that some relationship exists between intermittent fever and marshy localities. But that this is a relationship of pure cause and effect cannot be affirmed; for the local conditions in this State have been essentially the same for a long period of years, and yet our river-banks and swamps and the vicinity of reservoirs have been, as a rule, absolutely free from malarial diseases. The gradual spread of these diseases over a territory habitually exempt indicates that some new influence not of a local character has come into play; an influence which moves slowly over the country, and in some way so modifies the air of wet and marshy localities as to cause, during the warm season, the appearance of malarial fevers, while in dry localities it passes by unnoticed, or is only observed as a slight "malarial tendency."

These conclusions, based entirely upon the facts now under consideration, are found to coincide with the views now generally adopted by medical authorities.

All of the leading medical and sanitary writers recognize wet soil or marshy surroundings as an essential factor in the production of the malarial poison. In support of this proposition, the following authorities may be cited: —

Aitkin.[1] — "Agues have always been observed to be the diseases of moist or marshy districts, and to prevail most in low, swampy, and humid countries, where seasons of considerable heat occur. The vicinity of marshes, or of a district that has at some recent time been under water; the banks of great lakes, and the shores of great rivers and seas, where the water flows slowly, and in some places stagnates in shallow rivers over land alluvial, low, and flat; extensive flat tracts of wood where much moisture is constantly present, where the process of drying is uninterrupted, and yet the surface constantly exhaling humidity, — these are

[1] The Science and Practice of Medicine. 1866. Vol. I., p. 477.

some of the terrestrial physical conditions in which the paludal and littoral forms are found to abound. It must also be admitted, however, that these diseases do not prevail in *all* marshy districts; and they cannot, in some cases, be traced to a residence in the vicinity of marshes."

Hertz.[1] — "Malarial diseases are usually endemic in character, rarely sporadic, and rarely advancing over large regions of country in the form of an epidemic. Their endemic occurrence is especially common in marshy regions; and the more extensive these are, the more frequent and severe, as a rule, will be the diseases in question. But all marshes do not bear this relation to disease, and there are even extensive swampy regions in hot climates that are entirely free from malarial fever. For their influence varies with the amount of water they contain: where the latter stands high, fevers are more rare; where the marshy ground is covered only by a thin sheet of water, and the latter is exposed to the heating influence of the sun, malarial diseases will abound, inasmuch as the decomposition of organic matter, and especially of vegetable matter, seems materially to aid in their production. Thus, the most favorable conditions for the development of this poison are offered by marshes that have dried up, while their injurious influence is materially diminished as soon as heavy rains once more submerge the previously parched surface of the ground."

Ford.[2] — "Moisture of soil is one of the main factors concerned in the development of malaria. In addition, there are required heat, air, and the presence of organic matter, especially of vegetable origin. The occurrence of malarious diseases is especially common in marshy regions. But other situations, such as damp bottom-lands, the oozy shores of streams, regions exposed to periodical overflows, and soils composed of impervious substrata, such as clay, which present an obstacle to the passage of water, are also favorable to the development of the agent which produces paroxysmal fevers."

Maclean.[3] — "Malaria is believed to be the product of organic decomposition in soils, whatever may happen to be their mineral composition. Water is indispensable to the process; and a high temperature, although not absolutely necessary, greatly aids it. It is generated in greatest abundance in marshes, which contain a high percentage of organic matter; hence the name by which it is familiarly known, viz., *marsh miasm*."

Murchison.[4] — "As to the nature of malaria we know nothing, except that with rare exceptions it appears to be generated in marshy, uncultivated places, where there is much decomposing vegetable matter, and especially in conjunction with a high atmospheric temperature. In England it was formerly a very common disease, but is now unknown, except in a few localities which remain undrained and uncultivated."

[1] Cyclopædia of the Practice of Medicine, Ziemssen. 1875. Vol. II., p. 563.

[2] Hygiene and Public Health, Buck. Chapter on Soil and Water. Vol. I., p. 579.

[3] Reynolds's System of Medicine. 1870. Vol. I., p. 593.

[4] Clinical Lecture on the Causes of Intermitting or Paroxysmal Fevers. Lancet, London. 1879. Vol. I., p. 617.

Similar views are expressed by Watson,[1] Tanner,[2] Flint,[3] Parkes,[4] Niemeyer,[5] Bartlett,[6] Hammond,[7] Metcalfe,[8] and Horton.[9]

As to the habits of malaria, it is found to be most active near the surface of the ground; so that even the second stories of houses sometimes enjoy a partial immunity. It will spread in a still atmosphere seven hundred to one thousand feet from the point of its origin, but is carried by winds to a distance estimated at from two to five miles. Winds will also drive it up hill-sides to a height of several hundred feet above the level where it originates. It has a great affinity for moisture, and is most active over the surface covered by fogs. Its spread is retarded by a sheet of water, which appears to absorb it. It is also absorbed by foliage, so that a belt of trees is often found to be an efficient barrier to its progress.

Nature of the Malarial Poison.

The exact nature of malaria, science has not yet been able satisfactorily to determine. While authorities agree that it is developed in marshy places, all recognize an unknown factor without which it is not produced, even in places otherwise most favorable. Lancisi in 1695 promulgated the theory that it is a poisonous gas developed by vegetable decomposition, under the influence of heat and moisture. But this does not stand the test of experience; for the same circumstances of vegetable decomposition will, in one place, be attended with development of malaria, and in another this result will be wanting. Moreover, the air of malarious swamps has been subjected to chemical analysis, and found to contain only watery vapor and carbonic acid in excess, with the addition sometimes of sulphuretted and carburetted hydrogen, free hydrogen, and ammonia. None of these gases are capable of producing the periodical fevers.

[1] Lectures on the Principles and Practice of Physic. 1855. p. 441.
[2] The Practice of Medicine. 1867. p. 167.
[3] A Treatise on the Principles and Practice of Medicine. 1868.
[4] A Manual of Practical Hygiene. 1873. p. 307.
[5] A Text-Book of Practical Medicine. 1873. Vol. II., p. 619.
[6] Fevers of the United States. 1856. p. 386.
[7] A Treatise on Hygiene. 1873. p. 179.
[8] Report on the Nature and Treatment of Miasmatic Fevers. Sanitary Commission Publications, p. 1862.
[9] Diseases of Tropical Climates. London, 1879.

Another and more plausible hypothesis was advanced by Professor J. K. Mitchell[1] of Philadelphia, in 1849. He ascribed malaria to "the presence of poisonous fungi in the atmosphere, sufficiently minute to be wafted about by the motion of the air, and acting upon the organism through the medium of the function of respiration."[2] If we suppose a minute cryptogamous plant, which will grow only upon wet or swampy soil; which produces microscopic spores, carried about like other spores, by the wind, develop whenever they fall upon the proper soil, but failing to develop on dry soil or on the surface of water; and whose spores are of such a poisonous character as to produce, when inhaled by man, the symptoms of fever and ague, — we have a rational and satisfactory explanation of the phenomena presented by the malarial poison.

This theory cannot be said to have been adopted by the medical profession, as it was based upon analogy and not upon demonstration; but it has been provisionally accepted as most nearly in harmony with the known facts. Since it was first suggested, several investigations have been made, whereby it seems as if the required demonstration had been approached and possibly attained.

In 1866 Dr. J. H. Salisbury[3] published the results of experiments, from which he was led to the belief that malaria is due to the minute oval spores of certain species of palmellæ, which he found in the saliva and pharnygeal mucus of persons affected with intermittent or other malarial fevers; and also in the form of a whitish or reddish film on recently-dried marshy soil, and over newly-turned-up rich and peaty soil. He also found these spores in the atmosphere of these places. By suspending plates of glass a short distance above the surface of the ground, in malarial swamps, and placing under the microscope the drops of dew found condensed upon them, he was able to demonstrate the presence of these spores. By placing boxes of the film-covered earth in the window of a bedroom, in a non-malarial locality, he believed that he produced intermittent fever artificially. This paper was received with great interest; and a corre-

[1] On the Cryptogamous Origin of Malarious and Epidemic Fevers. 1849.

[2] Hammond, op. cit., p. 179.

[3] On the Causes of Intermittent and Remittent Fevers. Am. Journal Med. Soc., January, 1866.

sponding disappointment was experienced when Professor H. C. Wood, jun.,[1] published, two years later, a criticism, whereby its effect was greatly weakened. Professor Wood showed that the palmellæ cannot live in the human body, and also that they grow everywhere wherever light and moisture are found, as well in non-malarious as in malarious regions, and without regard to temperature. It was also found by repeated experiments, that neither the swallowing of these organisms, nor sleeping in the room with them for months, produced intermittent fever.

Horton, in his "Diseases of Tropical Climates" says, that Dr. Massy, of the army medical staff, while serving in the malarial regions of Jaffa, detected minute vegetable sporules in many of the secretions and excretions of the body, and pointed out their relation to the diseases of the region.

Dr. Billings,[2] in his Introduction to Buck's "Hygiene and Public Health," says, —

"The latest announcement of the microphyte causing this disease is made by A. F. Eklund, surgeon of the Royal Swedish Marine, who claims to have discovered in the blood and urine of those thus affected a peculiar organism known as the lymnophysalis hyalina. This requires confirmation, very much."

Parkes [3] states that

"Dr. M. P. Balestra has described spores and sporangia of a little algoid plant in the air of Rome and its vicinity; and the same plant is found abundantly in the water of the marshes near Rome. Balestra is inclined to attribute marsh-fever to this widely-diffused 'microphyte granule.'"

Professors Klebs of Prague, and Tommasi Crudeli of Rome,[4] made, in the summer of 1879, some most interesting experiments upon the soil of the Roman Campagna and the Pontine Marshes. In numerous experiments they produced the symptoms of intermittent fever in rabbits by injecting them with solutions of the soil and air of marshes. The soil and water were found to contain a peculiar fungus which "appeared as small rods of .002 to .007 millimetres in length,

[1] Am. Journal Med. Soc., October, 1868.

[2] Page 26.

[3] Op. cit., p. 107.

[4] Medical Times and Gazette, London, 1880. I., p. 58. From Archiv. für exp. Path. u. Pharm. Leipzig. XI.

growing into long, twisted threads, which, after some time, became furnished with joints at the surface of the liquid exposed to the air, or formed the so-called enduring germs in their interior." The germ was found to die unless having free access to air. This was believed by these experimenters to be the true "bacillus malariæ." If the solution was filtered, the filtrate did not, when injected, produce intermittent fever. The fungus was developed in the fresh serum of rabbits, and injection with this serum produced the same symptoms. All the rabbits, when killed, had enlargement of the spleen, which contained a dark brown pigment. The spleen and lymphatic glands contained very small bright corpuscles, which developed after twenty-four hours in a suitable medium into threads filled with spores. Formation of pus, or any other changes due to inflammatory or septic processes of the different organs, were entirely absent.

Such experiments as these are extremely useful; but until repeated, with similar results, by many observers in many localities, they cannot be admitted as conclusive. In the mean time the germ-theory of malarial fevers may be considered as having the weight of evidence in its favor. But theories, it should be borne in mind, serve merely to formulate the knowledge acquired up to a given time; if too dogmatically adhered to, they serve to retard scientific progress by checking the spirit of inquiry.

Of other theories which have been advanced, the most worthy of mention is that of Dr. C. F. Oldham,[1] based upon long observation in India. He attempts to prove that the malarial fevers owe their origin not to marsh-poison, but to the debilitating influence of long-continued heat. The same view is adopted by Dr. Charles T. Reber[2] of Shelbyville, Ill.

Dr. J. W. Penn[3] of Humboldt, Tenn., states his belief that "the remote cause of malarial diseases is enervation, from privation of electricity caused by the evaporation of pure water;" while Dr. F. W. Abekan[4] attributes them to an "excess of ozone."

[1] What is Malaria? London and Calcutta. 1871.

[2] Thermal Paresis, the so-called Malaria. St. Louis. 1879.

[3] Etiology of Malarial Diseases. Trans. Med. Soc. of Tennessee. 1879, p. 68.

[4] A Contribution to the Etiology of Malaria. St. Louis Clinical Record, September, 1879. VI., p. 61.

Each of these three theories, whatever apparent foundation for them exists in a region where malarial fevers are endemic, becomes unsatisfactory when applied to New England; for the temperature of this region has not undergone any marked change; and if peculiarities of the electrical conditions, or an excess of ozone, could produce these fevers, we would expect to find them appearing simultaneously over a large region, instead of slowly creeping from town to town.

Prevention.

Whether malarial fevers are preventible, and, if so, by what means, are, from a sanitary point of view, the practical questions in connection with this subject. That their prevention is possible, is proved by the fact that it has in many cases been accomplished. Drainage has almost invariably been the means employed. Of their diminution or suppression in many parts of Europe, by this means, medical literature contains abundant instances; and in this country also the same result has been attained. By way of illustration, a few of the most recent cases will be cited.

Dr. A. N. Bell [1] reported in 1874 several instances in the State of New York, where intermittent fever had disappeared as a result of systematic drainage. One of these localities is the vicinity of Prospect Park, Brooklyn; another is New Utrecht, in the same county, where the disease has become much less prevalent, and "the storekeepers facetiously complain of the Drainage Commission for injuring their business in the sale of quinine, which, until recently, was an article of considerable profit to them." In Cayuga County in consequence of the removal of obstructions from the Seneca River, the Montezuma marshes have become largely drained, with the result of causing a great diminution of intermittent in that district. "It used to be a proverb in the county, that anybody who slept one night at Montezuma would have the fever and ague to pay for it. A resident of that vicinity — an intelligent and educated man — says that there is not one case of intermittent fever now in that section, where there used to be a hundred before the marshes were drained." In the city of Poughkeepsie, at one time, there

[1] Defective Drainage as a Cause of Disease in the State of New York. Trans. Am. Med. Asso., vol. 25. 1874, p. 433.

were twelve hundred cases of intermittent fever; but, since the lakes and swamps were drained, there has been scarcely a case. Other instances of a similar character are mentioned.

Professor J. L. Cabell[1] reported also in 1874 similar results in the State of Virginia. He showed that previous to the war the drainage of wet lands for the purpose of cultivation caused in many localities a marked diminution in the prevalence of malarial diseases; but, during the few years following the war, these were increased, in consequence apparently of the general neglect of cultivation and drainage. Latterly, drainage having been again adopted in some places, a decided improvement in the healthfulness of those localities had followed.

In Maryland a steady decrease in the frequency and severity of malarial fevers during the past twenty years is reported by Dr. E. Lloyd Howard[2] of Baltimore; and this decrease he attributes mainly to "an improved drainage consequent upon a better cultivation of the soil."

In Indiana, it is stated by Dr. Garrish,[3] who lives on one of the drift-wood tributaries of the White River, that his district, which was formerly very malarious, is now much less so, owing to drainage and cultivation.

In certain parts of Ohio, the same result has been brought about by another method. Dr. G. Volney Dorsey[4] of Piqua shows that the health of the country has been improved by the construction of artificial reservoirs, specifying those in Licking, Mercer, and Logan Counties. He describes the last of these as located on the site of extensive swamps, overflowed in spring, and uncovered, or nearly so, in summer; and constructed by building up the banks to prevent extensive overflow, and keep the ground within constantly covered. Now, "although the population has increased many-fold, there are perhaps fewer cases of fever every year than among the very sparse population before the work was begun."

[1] Report on Defective Drainage as a Cause of Disease within the Limits of the State of Virginia. Trans. Am. Med. Asso., vol. 25. 1874, p. 477.

[2] The Decrease of Malarial Disease in Maryland. First Biennial Report of State Board of Health of Maryland. 1876.

[3] St. Louis Med. and Surg. Jour. August, 1879.

[4] Remarks on Malarial Fever. Cincinnati Lancet and Clinic, Feb. 21, 1880. Vol. IV., n. s., No. 8.

Although this last method was the very opposite of drainage, it yet accomplished the same result; for, by preventing extensive overflow in the spring, it rendered the country more dry, and, by keeping the muddy bottom covered with water, withdrew it from the influence of the sun and air.

For checking the development of malaria in Massachusetts, no special measures can be indicated as applicable to all cases. Each locality presents a distinct problem for the sanitary engineer to solve. It may be generally stated, however, that whatever measures can be employed for the drying of wet lands, and the obliteration of swamps, are likely to secure the desired result. This may sometimes be effected by simple drainage; but, in many cases, very serious difficulties present themselves. For example, several of the most active foci of intermittent fever are artificial swamps, caused by the drawing down of great, shallow reservoirs, exposing to the sun and air an extensive surface, covered with decaying vegetation, and the condition aggravated by a daily rise and fall of such water as remains. These are typical breeding-places for malaria; and the facts collected from Massachusetts and Connecticut show that such reservoirs have repeatedly become centres of epidemics. But, since an interference with these reservoirs might prove a serious detriment to the manufacturing interests of the State, and consequently to the welfare of the people, great care should be devoted to their consideration. In cases where such reservoirs are of little value, although active centres of disease, some equitable method may be devised for effecting their discontinuance, and the cultivation of the land which they have occupied. In the majority of cases, however, some other course would be preferable. The danger from these reservoirs lies in their great extent and trifling depth, whence they inevitably become swamps in summer. To confine them within dikes, after the manner of the Ohio reservoirs described by Dr. Dorsey, would, by diminishing the surface and increasing the depth, produce a salutary result. In some cases, much good would result from requiring that a certain minimum depth of water should always be maintained, so as to prevent the uncovering of large areas of muddy bottom. It is important that a careful survey be made of such of these reservoirs as become

malarial centres, with a view to effecting their sanitation, if possible, without doing at the same time a greater harm than the desired end will justify. Although, in former epidemics, the removal of dams was several times resorted to with success, yet at this time, when reservoirs have become far more numerous than then, and the State has become essentially a manufacturing one, any such radical measures would prove most disastrous to the interests of the community; and some other method should be earnestly sought for.

In regard to the Connecticut River, the difficulties appear even greater; for it seems impossible to counteract the malarious influence of a season of extremely low water. Such seasons, however, are happily not very frequent. The drainage of low lands on the borders of the river, and perhaps the construction of dikes in some places to prevent extensive overflow in spring, are practicable and useful measures.

As an obstacle to the diffusion of malaria is presented by masses of foliage, the planting of trees along the margins of reservoirs and streams would be a valuable means of protection. The amphibious habits and rapid growth of the willow specially adapt it to this purpose.

The question naturally arises, whether the same measures which tend to the extermination of malarial fevers in regions where they are endemic, will prove equally serviceable in the case of an epidemic, such as the present one. To this it may be replied, that, since these diseases are governed, in the present case, by the same laws of locality which obtain in those regions where it is endemic, it is impossible to believe that their re-action to preventive measures should not be similar. Although the morbific influence has been spreading gradually over a new territory, it has selected for its most decided manifestations such localities as are elsewhere its favorite resorts. It has passed but lightly over high and dry places, producing only here and there a few mild cases of intermittent or remittent fever; but, like the migratory water-fowls, has made the ponds its resting-places, and has lingered on the marshy borders of the streams. If, therefore, in its progress, its development is great in some places and trifling in others, the only logical course will be to endeavor to place all localities as nearly as possible in the condition of those in which it is the least prevalent.

The future course of this epidemic it is impossible to predict. Whether the disease will soon disappear, as has been the case in its previous visitations, or will take up its permanent abode among us, cannot yet be foreseen. As to whether in the epidemic of 1793–99 it was the removal of dams which stamped it out, or whether it would have similarly receded if nothing had been done, the evidence is hardly sufficient to justify an opinion. The history of the present epidemic in Connecticut, however, is not such as to indicate a speedy relief from natural causes; for malaria has now existed on the shore of Long Island Sound for thirty years consecutively. Yet it is encouraging to know that in the southern part of the State its influence is apparently on the wane, although in the central portion, where it has existed for nearly a decade, it is still on the increase.

Epidemics of intermittent fever have sometimes been the forerunners of epidemics of dysentery, cholera, or other diseases of like gravity; but, since Connecticut has escaped any such scourge, no such sequel need be anticipated here. It is, however, a suggestive fact that, cerebro-spinal meningitis has recently become endemic in Connecticut, prevailing more especially in malarious districts.

That the future appearances of intermittent fever and other malarious diseases should be carefully observed, is highly important. The present report is necessarily imperfect, and should be followed by more extended and more accurate observations. By carefully noting all cases of malarial fevers and their topographical surroundings, physicians may render material aid toward the adoption of practicable measures for the prevention of this class of diseases.

SCHOOLHOUSE SANITATION.

BY

ERNEST W. BOWDITCH, C.E.,
BOSTON.

SCHOOLHOUSE SANITATION.

The value of any consideration of school sanitation will depend in great measure upon the extent of territory from which facts have been gleaned. The school buildings visited in the preparation of this paper are 65 in number, containing 296 rooms, and having a seating-capacity of about 15,000 pupils. Throughout the Commonwealth there are 5,558 public schools (Board of Education, 1878–79), containing 311,528 pupils: it will be seen, therefore, that about 1.5 per cent only of the schools have been visited, containing 4.8 per cent of the number of pupils. Although the examinations are somewhat limited, it is hoped that this report will not prove entirely uninteresting or profitless.

Examinations have been confined to New Bedford, Lowell, Holyoke, Springfield, and Salem; an examination of the latter embracing one building only, as a similar but more thorough examination was being conducted at the same time by the city.

These only show certain types of buildings, — such as one might expect to find in manufacturing cities, together with a few distinctive mill schools, the latter, however, not sufficiently numerous to show conclusively what may be the defects in similar buildings in other portions of the State. Naturally the bulk of the testimony as to the comforts or discomforts of buildings and their surroundings must come from the teachers, as the conclusions arrived at from a chance visit to a school cannot be considered as necessarily showing its average good or bad features; but it has frequently been found that teachers evade giving direct answers to questions, either from a feeling that it may be unwise to express an opinion in any way, or from false modesty. This has been

the case in several instances where the buildings had already acquired a local notoriety, and to which attention had been specially called. It is a great pity that it should be so; for not only does it make the work of the inspector much more difficult, but the results derived from the examination are neither so reliable nor comprehensive as they might be, and defects, possible to remedy if known, may be overlooked from insufficient familiarity with the premises under inspection.

Much curiosity was felt in regard to the relative sanitary condition of State, town, and private schools: so far as examination has been carried, the town schools are entirely capable of holding their own, although individual instances may seem to indicate the contrary. The State schools would naturally be looked to as the best, and the private academies the poorest, if for no other reason than that the Commonwealth and towns are financially able to maintain such institutions far better than most individuals or corporations.

Attention was first called to New Bedford schools; and at the end of September, 1880, all such buildings, except two near Acushnet, were visited.

New Bedford is singularly well situated for ample and proper drainage, being mostly on a ridge of land running about north and south, and between Acushnet River on the east and Tripp's Brook on the west. Most of the ground is high enough to be easily drained, and the subsoil is none of it such as to present extraordinary difficulties. It is in a large degree a wooden city; and a majority of the school-buildings are simple frame structures, more suitable for a smaller town, and scarcely adapted to the heavy use to which such places are subjected when crowded.

The city is furnished with an abundance of water, which is pumped from the Acushnet River to a reservoir at the north end of the city, and almost all the schools are supplied with it. The sewers and other arrangements for carrying off the refuse liquids are understood to be not altogether desirable; and in several instances the rules of engineering have not been strictly followed in regard to location and construction. There is good reason to hope, however, that this state of things has passed, and that hereafter the sanitary arrangements of the city will be under the immediate direction and

supervision of persons whose education and observation especially fit them for devising and carrying out proper plans. Some sewers will doubtless have to be re-laid, before a proper service from them can be expected, and many changes made in the way of extensions, etc., both of mains and laterals; possibly it may be needful even to entirely remodel the present sewerage system before the maximum of healthfulness can be obtained.

Be that as it may, there is no physical reason why New Bedford should not be well and sufficiently drained, at no large expense; and the tide of three feet and three-quarters will remove sewage far enough to make it unobjectionable. It may need an intercepting sewer, a pump, settling-basins, etc., at the lower extremity; but it can be done perfectly well, if the necessity for it is proved.

Altogether, fifteen public schoolhouses, besides the Friends' Academy, were visited, that may be called regular day schools; and certain rooms in these same public school-buildings are used for evening classes. One of these is known as the "Mill School," on account of being attended almost wholly by mill-children.

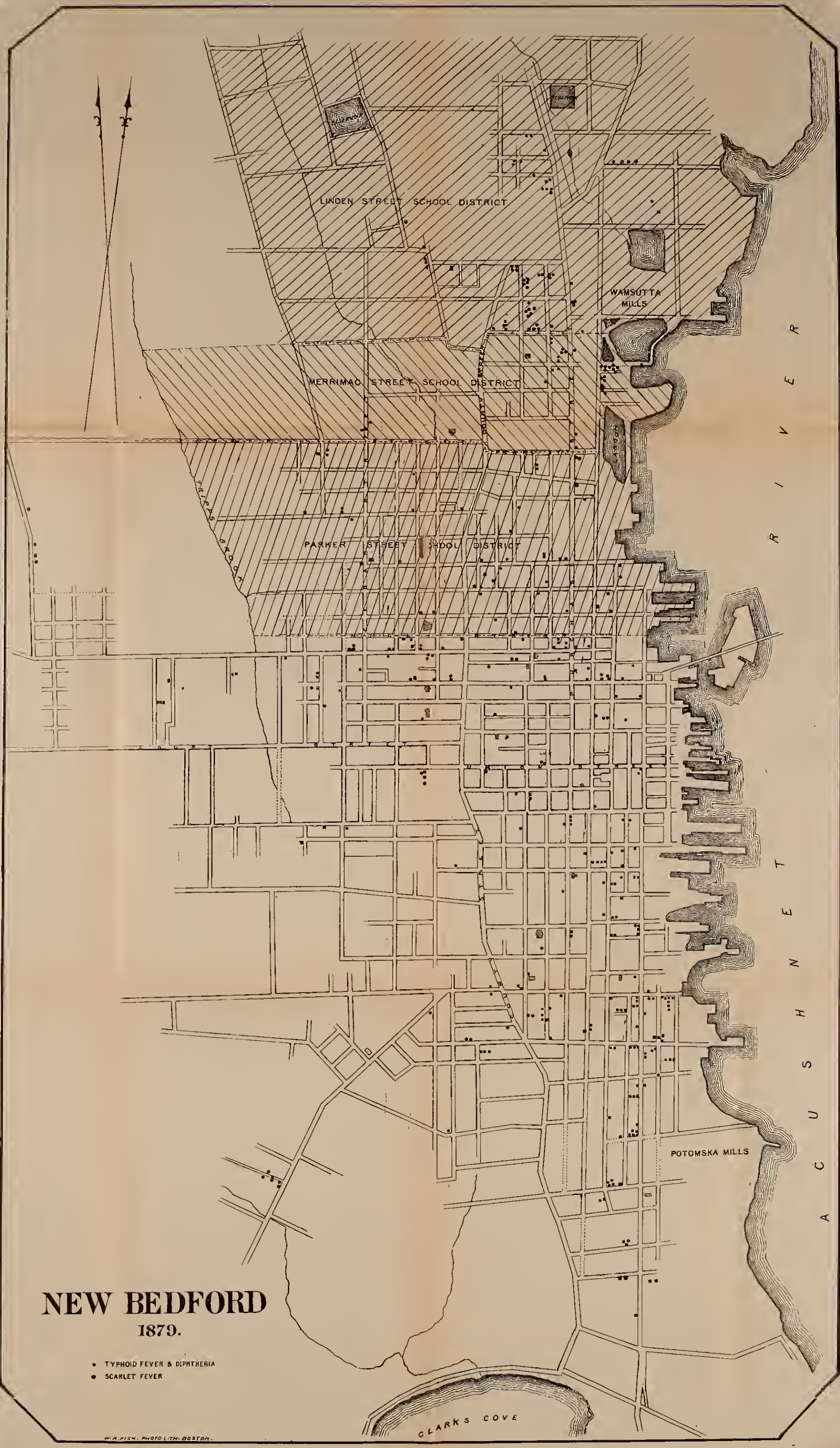
Operatives of the Wamsutta and Potomska Mills, the Cordage Company, Blue Works, etc., form a large element of the population; and it would be in the districts occupied by these people that one would naturally seek defective sanitary arrangements. Inspection of the health records in a measure corroborated the theory; and the preparation of sanitary maps of the city from the records of zymotic diseases, that are from time to time reported to the State Board of Health, Lunacy, and Charity, justified further investigation.

Of course the causes can only be surmised: it is safe, however, to say that in certain places the sewer system is known to be defective, and the drainage arrangements of certain of the schoolhouses are scarcely such as to inspire unbounded confidence. The heating and ventilation also are susceptible of criticism; but, as these latter are constantly being changed for the better, they may be considered as of minor importance. Few if any of the buildings are perfect; but the greater number of them are in by no means bad condition, and one is led to believe, that, with possibly two or three

glaring exceptions, every thing *known* to be out of order has been attended to. In order to have some basis to work upon, the opinion of the townspeople as to the most unhealthy portions of the city was obtained. It was the general impression, that in the district known as "Africa," on the slope facing Tripp's Brook, the sanitary arrangements would be found wanting. Actual putting on paper of the local health records told a different story: though "Africa" may not be as it should, it is certainly not the worst, unless the records are defective; and this introduces at once the importance of keeping, worked up to date, not only for schools, but general purposes, regular

Sanitary Maps.

In almost all cities and towns where there are local boards of health, and where daily record is kept of the cases of filth-diseases, there appears, almost uniformly, to be lack of definite knowledge in regard to the locality in which sickness prevails. To the question, "What district of the town is free from filth-diseases?" the answer comes, "It is *presumed* to be such a one," or, "It was so and so last year," or a direct answer is evaded. There is no reason why the record cannot be kept, so that answers to all questions of the kind should cease to be doubtful, and become matters of certainty. Such maps are made to a certain extent, at the end of the year, in some few places; and, though of use ever after as a reference, they do not accomplish all they ought. They should be ever ready, and prepared to date. It is presumed that all communities sufficiently advanced to maintain local health boards have also lithographic town plans. If, on one of the plans, the location of the different cases of zymotic disease be indicated by dots of proper colors, — a different one for each class, — a very instructive record is produced; and if continued a few years, taking a fresh lithograph every year (or, if the places be so thickly settled as to make this impracticable, at stated intervals of shorter duration), the record will be found very interesting, and frequently even startling. It is all very well to keep a written record of individual cases, and, if but one record is kept, that is undoubtedly the best; but to show the entire district pictorially, so that the whole record can be studied at once, is an



NEW BEDFORD

1879.

- TYPHOID FEVER & DIPHTHERIA
- SCARLET FEVER

W. H. FISH, PHOTO-LITH. BOSTON.


LINDEN STREET SCHOOL DISTRICT
MERRIMAC STREET SCHOOL DISTRICT
PARKER STREET SCHOOL DISTRICT
WAMSUTTA MILLS
POTOMSKA MILLS
COGGESHALL
TRIPP'S BROOK
ACUSHNET RIVER
CLARK'S COVE
NEW BEDFORD
1880.
TYPHOID FEVER & DIPHTHERIA
SCARLET FEVER
R. H. FISH, PHOTO-LITH. BOSTON.

immense advantage. Maps of this kind are shown for the years 1879 and 1880, for New Bedford, indicating diphtheria and typhoid-fever by the same sign (a square), and scarlet-fever and canker-rash together, in similar manner, by a circle. The time taken to prepare such plans is very little, — three or four hours per year only, in addition to the time expended on the regular record. It is difficult to see how, otherwise, precautionary measures can be taken for any district intelligently, unless sickness has already taken the form of an epidemic. In New Bedford, for instance, it will be seen by inspection that scarlet-fever and canker-rash have been much more frequent just west and north of the Wamsutta Mills, than anywhere else, for the years 1879 and 1880, and have increased very much the latter year: from which it may be reasonable to suppose that some of the more common sanitary precautions have been neglected. (A very good written record is kept at the health office, but no ready reference. It should be stated that the suggestion was accepted by the board as one of importance.) In the first place, it is notorious that much sewage runs to what is called the "lagoon," and to a point just south of Wamsutta Pond, from the district indicated; and the bulk of it probably remains there on the flats. In other words, the sewerage is not as it should be. The district was formerly quite springy and marshy, but was never properly drained, although partly filled up.

This would scarcely be a reason why more sickness should exist there in 1880 than in 1879, though it might indicate general unhealthiness. The class of people who live in that quarter, the buildings they occupy, and their manner of living, would have much to do with it; and the schoolhouses may help to tell the story. There are three of them, — Parker-street, Merrimac-street, Linden-street. Parker-street School is the largest in Bristol County. It contains ten schoolrooms and a hall, with a seating capacity of 560 without the hall, or 680 with it. The number of pupils now (Sept. 30, 1880) is 498. The ventilation is only by doors and windows; although, in the new portion, attempts have been made to carry out another plan. Acushnet water is used in the building, in four sinks and one water-closet. In spring there has been standing water in the cellar, and they are troubled by smells. After repeated notifications, blind

drains have been put in the cellar, which help but do not entirely remove the difficulty, as it is still at times very damp. A portion of the floor of the cellar has been raised by a deposit of ashes. The building is heated by five furnaces, and a portion of the air-supply is cellar air. Outside the building, the boys' privy, accommodating fourteen, is not very nice; and the urinal is disgusting. The arrangements for the girls, not so large, are twenty-five feet from, and directly facing, one of the cold-air boxes for furnace supply. During the three months ending Dec. 31, 1880, there had been twenty-one cases of diphtheria or scarlet-fever, and thirteen scholars were detained at home on account of one or the other disease in other members of the family. The door-window ventilation seems to be well managed. The janitor's work is fairly-well done, considering the building.

Merrimac-street School (stove-heat) contains six rooms, with seating capacity of 294. There are 281 pupils, whose ages vary from five to thirteen years, now on the list. Acushnet water is in hallway sinks only. The wastes and the house-leaders (which run the entire length of the basement) all connect with the sewer.

There is no water in the cellar. The leader wastes are in the basement, and are three and one-half inches in diameter, have slip-joints, and aggregate 120 feet in length; beside which there are fifty feet more of lead sink waste, and at least one line of pipe under the cellar floor. The ventilation is poor, and the occupants have been troubled at times with bad smells, that they thought came from the sinks, though they were told otherwise. The smells were noticed at no special times, but occasionally lasted a day or two. Peppermint showed at least ten different leaks in the basement, and came up all but one of the sinks, other than the one through which it was introduced. There is no trap visible in the building; but probably there is a large one outside the walls that at times is sucked out, or evaporates, and then the building acts as a ventilator for the whole sewer. Outside the building there are brick privies, with hard-pine woodwork; both sides very filthy, and only half ventilated. There is no urinal of any kind. From Jan. 1, 1880, to Jan. 1, 1881, there have been seventy-one cases of scarlet-fever or diphtheria, with three deaths, besides fifty cases of measles.

The trouble here appears to be, mainly, defective house-drainage.

Linden-street School has four rooms, with a seating capacity of 235. There are at the present time 221 pupils on the list, whose ages vary between five and twelve. Dependence is placed upon stove-heat and window-ventilation, except in one room which is ventilated into the attic. Acushnet water is drawn from a sink on each floor, and the untrapped wastes connect with sewer(?). The surroundings at the rear are not nice; though they have not been troubled with any *particular* smells, and there is no standing water in the cellar. During the year there have been twenty-three cases of scarlet-fever, and three of diphtheria, causing three deaths.

These three schools include a majority of the children living in the district alluded to, and will serve to show, perhaps, the general condition of things in what possibly is the worst district in New Bedford. More definite data could undoubtedly be obtained, by making a regular sanitary survey of the locality; but such an one was not attempted, as the condition of the *schools*, rather than the city at large, was desired.

Cedar-street School contains six rooms, with seats for 294. At the date of visit the number of pupils was about 250, their ages varying from five to ten years. The ventilation is by windows only, though another method has been attempted; and for warmth they depend upon steam-heat. A concrete floor on the cellar keeps things moderately dry, though there seems to be standing water within two feet of the cellar floor. The water-closets are all in the basement, underneath one of the school-rooms; and the ceilings in the basement are neither lathed nor plastered. The steam boiler is at one end of the closets, and warms the building thoroughly, — water-closets, urinals, and all. The boys' and girls' sides are separated by proper partitions, but the closets themselves have no separation, and little ventilation; as a consequence, there is a sickening smell up to the top of the basement stairs. It seems, too, as if the smell must work up through the unplastered ceiling into the schoolroom overhead. Peppermint showed that the drains were not tight in the basement. Complaint was made of a pig-pen on the opposite side of the street, but at the time of the visit there was no evidence of any trouble from that source. A neighbor's privy and poul-

try-yard are within seventeen feet of one side of the building, and fourteen schoolroom and hall windows look out on them.

"There have not been many absences lately, not over twenty from sickness, and but two deaths, and those happened in vacation." The janitor's work is fairly done. If the water-closets are not removed or very much better ventilated, the building should be vacated for sanitary reasons.

The High School contains nine school-rooms, draughting-room, laboratory, and hall, with seating capacity of 336; though there are now but 240 pupils, whose ages vary between eleven and twenty years. The building is of brick, erected in 1876, is heated by indirect steam, and the service appears to be thoroughly done. The ventilation, too, is excellent, and the best yet seen. The basement has a concrete floor, and is fitted with sixteen water-closets, eight for the girls and an equal number for the boys, with the addition of eight urinals. Every thing is ventilated into a special shaft, thoroughly and well, all woodwork properly shellacked, and closets arranged so that the brick trench they empty into can be thoroughly flushed at any time. Leaders run by *separate* pipe to sewer. The water-closet waste from the upper stories (not ventilated) passes through the boiler-room in proper cast-iron pipe hung from the ceiling. The piping is rather complicated perhaps, there being seven lines of waste altogether, and the upper closets and pipes are unventilated; but all work has been thoroughly well done, and in accordance with perhaps the best knowledge at the time the building was erected. The closets in the basement were made after suggestions obtained from former reports of the State Board of Health. The only questionable thing noticed was the use of "cellar air" for the steam radiators instead of that from outside. It is true, it is much easier to heat cellar air in cold weather; but, at the schoolhouse in question, a number of the radiators are in the same apartment as the water-closets, so that occasionally *water-closet* air, instead of cellar air, is introduced into certain of the rooms. This is not an agreeable idea, though in this case the apartment is *entirely sweet* and every thing comparatively new; but with a careless janitor, and old and unclean closets, the result might be excessively filthy. It is desirable to note that the janitor's

work is specially deserving of mention, the entire building being as clean and sweet as can be desired.

Maxfield-street Schoolhouse was so troublesome, the old building was removed, and a new brick building is now in process of erection.

The Mill School is in the second story of an old wooden building, and has a seating capacity of 69, though there are 70 pupils, whose ages range from ten to fourteen. Stove-heat is depended upon. Windows are on three sides of the schoolroom, and they are troubled at times with bad smells from the back yard, but not enough to oblige them to close the windows. "There is very little sickness of any kind." The lower room, similar to the upper, till recently has been used only for evening classes: it is now, however, divided into two, temporarily, and accommodates classes from the old Maxfield-street School. There is one sink, untrapped, in the room, no cellar of any description, and stove-heat. "One case of sickness only." The smells from the privies at the back necessitate the closing of the windows, and fires are built every morning (September) to dry off the dampness. Smells sometimes come up the sink, but it is not known whether from a cesspool or sewer. The privies at the rear are not very nice.

Kempton-street Schoolhouse is old, but quite neatly kept, and not to be found fault with. The privies outside, particularly the boys', are not creditable: one would scarcely think the boys' privy fit for animals.

Middle-street Schoolhouse is lacking in proper ventilation: the water-closets are in the basement, and the heating is like that at the High School. "There is considerable smell from the neighborhood during the dog-days, and occasionally from the basement when the janitor neglects his duty." A large private school near by has very defective plumbing. Among the materials noticed as being made use of for waste-pipes and plumbing, are wood, tin, sheet copper, zinc, cast-lead, cast-iron, and cement. The existing arrangements are faulty, both in theory and construction, and should not be left in their present condition. Janitor's work is tolerable.

William-street School has now an attendance of 151, though the accommodations are for 200. Two years ago there was considerable diphtheria, but there have been only

two or three cases the past year. The conveniences are all in the basement, and, though fairly arranged and ventilated, are very contracted and dark, and the cellar is not particularly clean. The urinal, as usual, was somewhat offensive, in spite of being supplied with thirty-six jets of water.

Bush-street Schoolhouse is one of the oldest in the city. The building itself, though old and illy ventilated, might be made far better by removal of the vaults. These are in a very filthy condition, and forbid the opening of windows on that side of the building at certain seasons of the year. "Some sickness."

Arnold-street School contains one room only, is stove-heated, has no cellar, and the building is below the street level and quite old. The seating capacity is 44, and the school is always full. There have been no cases of scarlet-fever or diphtheria, and very few absences from sickness of any kind. Two small unventilated privies at the rear constitute the entire sanitary accommodations.

Fifth-street School is in a large brick building with seating capacity of 500. The ventilation is very fair, the heat is by four furnaces, and there are both basement water-closets and outside privies. The drains in the building are not perfectly tight, and the outside urinals are apt to prove troublesome on the approach of warm weather. The basement water-closets will become foul unless carefully used and attended to: the boys' urinal is quite filthy, and if rebuilt on a different plan would be better. The building as a whole is neat, and there is evidently great effort on the part of teachers to have the outside arrangements in good order. A little more janitor's work would not be objectionable.

Acushnet-avenue School has a seating capacity of 386, and pupils' ages range from five to eleven years. Last season, out of 260 pupils, there were twenty cases of diphtheria and ten of scarlet-fever, including several deaths among the younger ones. This seems to be a case where sewer and private drains appear to ventilate into the building. The closets are in the basement: they are not neatly maintained, nor decently ventilated. In those on the girls' side (hopper-closets with the valves operated by the seats) the valves are wedged so that little or no water runs. Several holes have been cut in the concrete floor to let off surface water that

sometimes runs in at the basement door and windows. There has been trouble from smells from the basement, and house leaders, particularly with east winds, and strongest in May and June. None were noticed, however, till the basement closets had been in use for one year. In the basement of this building are two rooms for evening schools for mill operatives. The rooms are but eight feet high, and illy ventilated. There are fourteen gas-jets in each room, and a seating capacity of 56. The steam-pipes are near the tops of the walls, an arrangement which must heat the heads more than the feet and bodies of the children. There is a good deal of difference shown here between the accommodations furnished the day and evening scholars. Outside, one of the house leaders is broken within a few feet of the ground, and the smell from the lower end leaves no doubt that it connects with the sewer.

The Dartmouth and Grove Schools are in old-fashioned, non-ventilated, stove-heated, poorly-drained, privy-accommodated buildings. At the former the water is obtained from a well that was suspected; and, although analysis failed to show any trouble with the water, it is not a proper source of supply, and in its present condition should not be used, as surface water can and does run in habitually. There has been little sickness in either building, owing, possibly in large degree, to a careful janitor.

In General.

The general impression derived from the inspection of New Bedford schools, is that while there are still remaining a number of antiquated specimens of school-architecture, entirely unsuited to the wants of the present time, both in heating, lighting, ventilation, and drainage, as now understood, the newer schools are arranged on entirely different and much broader and better principles, more thoroughly heated, lighted, and drained, and attempts are made (with only partial success, however) to have a regular system of ventilation; that the almost universal introduction of Acushnet water has in all cases been directly beneficial, not only in supplying better water than could be obtained from wells or cisterns on the premises, but also, in many cases, by supplanting privies and outside urinals, by water-closets, latrines,

etc., in the school buildings. It is found that certain existing practices of having *basement* water-closets, improperly trapped wastes, and badly arranged urinals, unless very carefully maintained, are liable to cause great discomfort, and possibly sickness; that the taking of "cellar air" instead of that from outside the building, for use of furnaces and indirect steam, is unwise; and that air-boxes, if terminated a few feet above the surface of the ground, instead of just on the level of it, would get better air, and be less liable to become foul at their entrance. Much of the sickness of school-children now existing, and reported at the health office, is unquestionably owing to defective local causes, mostly preventable at slight expense, possibly not at the schoolhouses altogether; and, though it would be unreasonable to expect at once a thorough overhauling of the present buildings, certain ones, easily selected, ought at once to be attended to, and should be considered as of prior importance to any new structures. A child had better be away from school entirely than be obliged to attend such an one as the Merrimac School in its present condition; and a very slight expense would render it quite a different place.

	No. of Rooms.	Seating Capacity.		No. of Rooms.	Seating Capacity.
Parker-street .	10	560 or 680	Friends' Academy, William-street .	2 4	140 200
Merrimac-street .	6	348	Arnold-street .	1	44
Linden-street .	4	235	Fifth-street .	12	660
Cedar-street .	6	294	Acushnet-avenue,	6	336
High School .	9	336	Dartmouth-street,	4	187
Maxfield-street Mill School .	2	125	Grove School .	4	195
Kempton-street .	4	216	Bush-street .	6	300
Middle-street .	9	450	Total . .	89	4,626

Lowell.

An examination at the city of Lowell was suggested by a series of articles in a local paper, relative to the Edson School; but it was not until partial changes had been begun there, that any inspection was made.

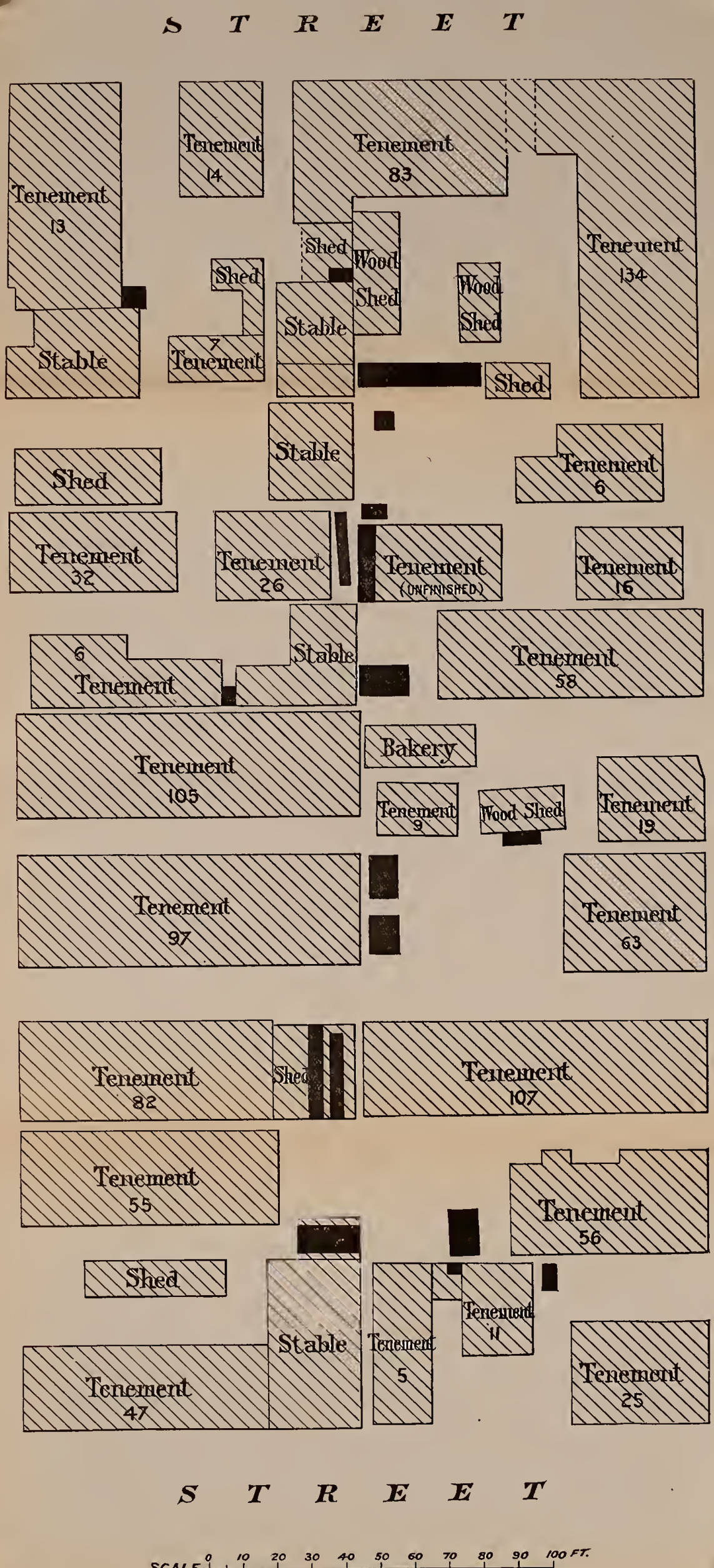
All the school-buildings in Lowell have not been visited; as, being the second city in the Commonwealth, and having

a population of some 60,000, there are a great many schools, scattered over a wide area. Therefore the results obtained do not of necessity show the condition of the remainder of the buildings. In addition to the regular public schools, there are in Lowell several large and newly-established parochial schools, for both sexes, that have all been visited and inspected in the same manner as other buildings, every desired facility having been afforded by those in charge. It is intended and believed that the results given, both for public and parochial schools, are perfectly impartial; credit being given where it seemed deserved, and fault being found where necessary, no matter upon whom it might fall. Before considering the public schools, it may be well to first call special attention to a certain portion of filled land, leased, it is understood, from the owners of the locks and canals for a term of years, and upon which great numbers of poor people reside. Both at Lowell and New Bedford, there seems to be a difference in the school-accommodations furnished poor children and those of better parentage. At both places the prevailing idea appears to be, that better accommodations would scarcely be appreciated; to test which, visits were made to the district known as "The Dump," or "Little Canada," a series of wooden buildings, covering considerable space, at the northern end of the city, inhabited by French Canadians, many of whom work in the mills. It is hoped and believed that "Little Canada" cannot be duplicated elsewhere in the city, and that laws may soon be passed forbidding the herding together of human beings in such a reckless manner, against all laws of health and decency. It is stated that there is now no State law which prevents the erection of such fire-traps, and that the utmost the local board of health can do is to watch until such time as sickness shall assume an epidemic character, and then close the blocks as nuisances. Close watch is kept on the district; and, though from ignorance many cases of disease are concealed, it is nevertheless known that much sickness exists there, particularly among the younger children. The slow process of decay, — for that it really is, — to which these children are subjected, though not necessarily a filth-disease, according to the general interpretation of the term, is aptly and suggestively called "tenement-house rot."

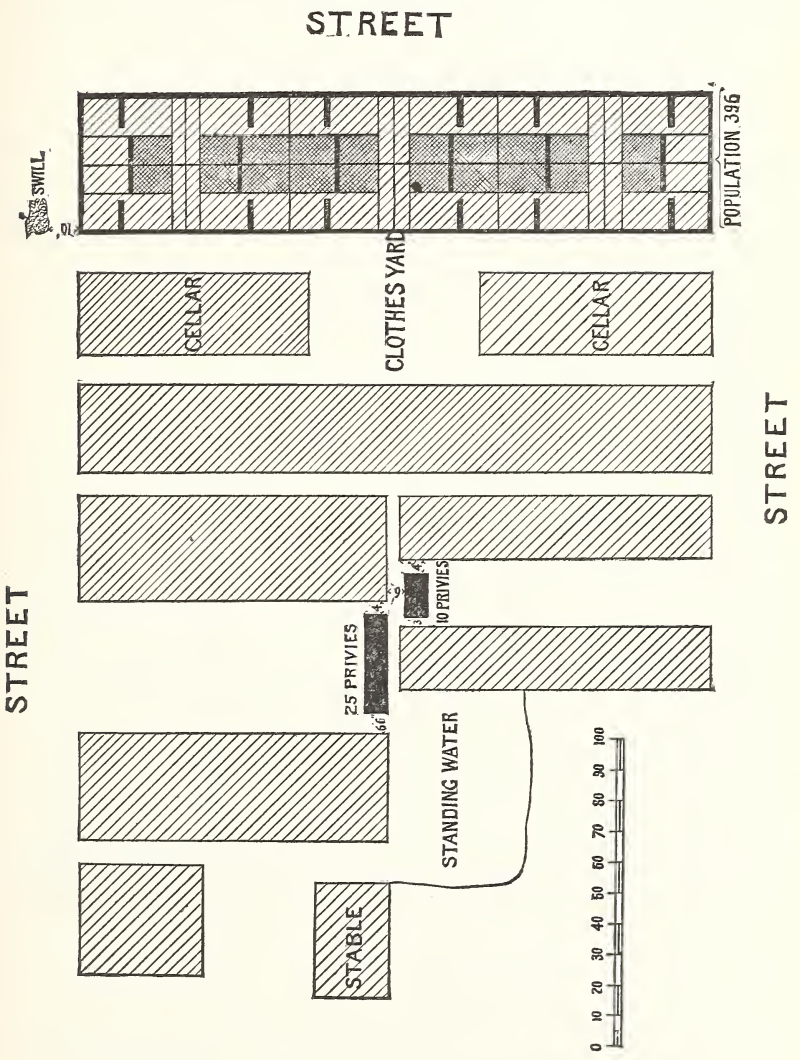
Of course the non-reporting of sickness (and filth-diseases or actual deaths are the only ones necessary to report) impedes the usefulness of the health-officers, and renders more than ordinary vigilance necessary. It can only be considered a question of time, therefore, when the blocks must be entirely overhauled and remodelled, or vacated for sanitary reasons; but as the buildings are many of them new, or nearly so, there has been as yet comparatively little sickness of zymotic type.

The accompanying plan represents one block of "Little Canada," with streets on all sides. Its area is less than two acres: its population, according to the census just taken, is 1,076 souls, who live in twenty-four tenement-houses. In addition to these, are one unfinished tenement-house, five stables, eight carriage and wood sheds, one bakehouse, and sixteen privies or slop-hoppers, the two latter having one hundred and fifteen divisions. The one tenement-house yet unfinished is, in construction, of the worst pattern; the ground-floor of one entire end of the building being occupied by privies, built into the house, and having sleeping-rooms overhead. In another place is found a first-floor tenement, vacated for reasons unknown, transformed into a public privy. The portion of the cellar beneath is walled off (hearsay), and holes have been cut in the floor for seventeen privy-seats and slop-hoppers. This is used by occupants of two buildings, and is, without exception, the foulest affair of the kind ever inspected by the writer. The place is infested with rats; and, having little ventilation, the stench is sickening.

The buildings are, most of them, three stories or less in height, and are so close together that it is difficult to pass between them. There are others (and with windows too) so close together on the side next the neighboring building, that a person cannot pass between, where the eaves overlap, and the rooms are dark at three P.M. Out of the windows it is not unusual to throw slops and swill, perchance into a neighbor's window if it happens to be open, and always with a confidence in the disinfecting power of Lowell air, that would be amusing if one could forget the sickness and misery such practices may create. There are no visible fire-escapes to these great tinder-boxes; and the widest space between

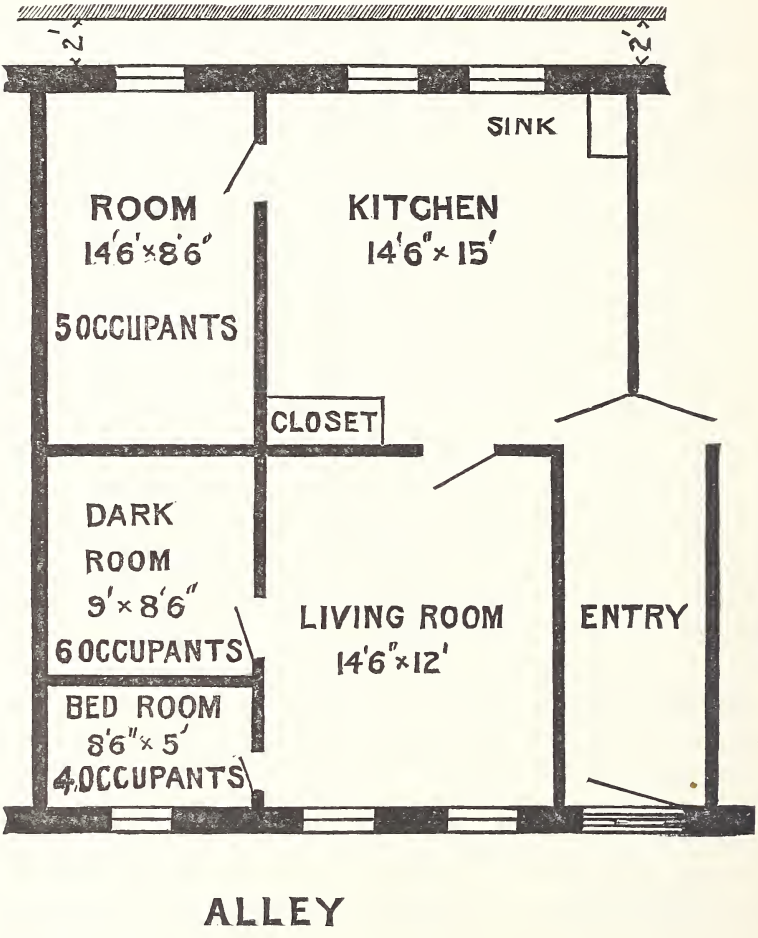

S T R E E T
Tenement 13
Tenement 14
Tenement 83
Tenement 134
Shed
Wood Shed
Shed
Stable
Wood Shed
Stable
7 Tenement
Shed
Stable
Shed
Tenement 6
Shed
Tenement 32
Tenement 26
Tenement (UNFINISHED)
Tenement 16
6 Tenement
Stable
Tenement 58
Tenement 105
Bakery
Tenement 9
Wood Shed
Tenement 19
Tenement 97
Tenement 63
Tenement 82
Shed
Tenement 107
Tenement 55
Tenement 56
Shed
Stable
Tenement 5
Tenement 11
Tenement 47
Tenement 25
S T R E E T
S T R E E T
S T R E E T
SCALE: 0 10 20 30 40 50 60 70 80 90 100 FT.

buildings, except openings that are by courtesy called yards is seventeen feet. They are apparently as well arranged for fire as the Madison-street (New York) tenement-house,



recently burned. In order to give an idea of the overcrowding in this district, it would be well to understand that in the most densely populated part of London, England, in the district known as East London, the population is at the rate

of 175,000 to the square mile; and in Ward Four, New York City, "supposed to be the most overcrowded city in the world," 290,000 per square mile. "Little Canada," all told, is very far from being a square mile; but the portion indicated (and there is no reason to suppose it more crowded



than any other part), allowing for forty-feet streets, is at the rate of 287,405 per square mile, and, be it remembered, for buildings, averaging scarcely three stories high. One of the newest buildings in "Little Canada," a huge, three-story, flat-roof caravansary, 206½ by 44½ feet, has a population of 396. Every tenement in this building (four rooms usually, except

the end ones) has two dark rooms, lighted by small high windows into the kitchen only; and totally-dark unventilated rooms are not infrequent through the entire district. Most of the tenants are, as before stated, French Canadians, and certainly have French thrift, for they take in boarders. These inside rooms are, many of them, *perfectly* dark; there being no windows of any description, nor ventilation save by the door, while the numbers of their occupants remind one of the Chinese. In a dark room 8 feet by 9 feet, and 8 feet high, were found sleeping-arrangements for three, — a breathing-area for each individual of only 192 cubic feet; another, 8 feet by 10 feet, accommodating three, — a breathing-space of 213 feet; another, 8.20 feet by 12 feet for three, — an area of 324 feet; and one of 14.5 feet by 8.20 feet for five, — an area of only 190 cubic feet for each. Outside rooms are even smaller; one being 7.5 feet by 8 feet, and another 7.5 feet by 7.5 feet, each for several persons. It is stated on good authority, that a physician, calling on a patient in one of these dens, found the family and boarders in such close quarters that the two younger children had been put to bed in the kitchen-sink. These sinks have no traps. One tenement of five rooms was occupied by a family of eight, and they claimed to be able to accommodate seven boarders. Cases like the above can probably be duplicated all over the district. The local board of health is entitled to considerable credit for having, by persistent efforts, succeeded in having sewers introduced into the settlement; although their compulsory use, and a simple and efficient system of plumbing throughout the buildings, instead of the abominable arrangements now in vogue, would greatly add to their value. Some few water-closets have been introduced into the basements of the newer blocks, and others have sink-drains connecting with the sewers; but the trapping of sink-drains, where any is attempted, is worthless; and great numbers of surface-privies still exist in the immediate vicinity of, and actually in, many of the buildings. The general surroundings of the district are as favorable as can be for general good health, situated as it is between the canal and the Merrimac River, and exposed to the full sweep of the north and west winds.

The reason given, that better school accommodations would be unappreciated, hardly seems to be a good and

sufficient one; for it is certainly fair and reasonable to suppose, other things being equal, that children prefer to be cleanly, and out of the region of constant smells, and that where such can be obtained without trouble to themselves they would be apt to appreciate the luxury far more than those whose daily life is passed in better quarters. At all events, give them a chance.

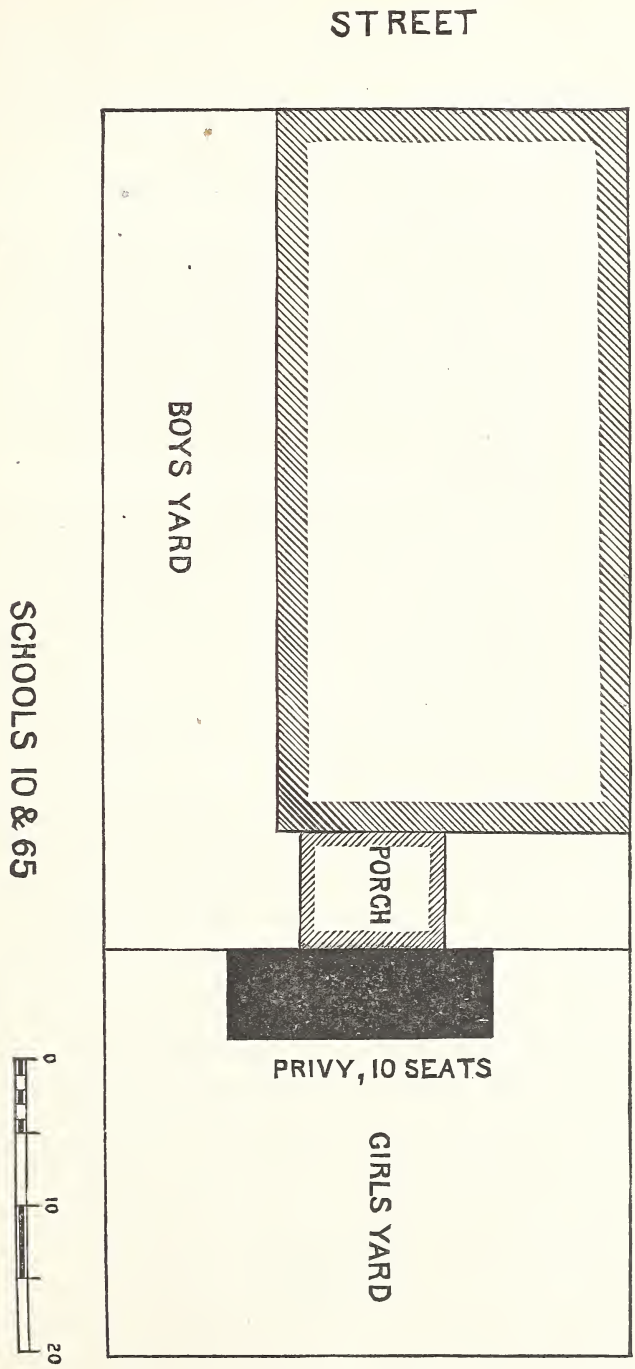
The first schoolhouse visited is in "Little Canada;" a new wooden building, that has been occupied only since September, 1880. There are 140 pupils now in the building; stove-heat is depended upon; city water in the hall only; there have been no absences from sickness; no smells, and privies are the accommodations at the rear. Both privies and urinal are rather filthy already. The building proper is fresh, and seems in good condition.

Another school, not far from the above, is built of brick, heated by stoves, and contains 150 pupils. There is city water in two sinks; and the privies are so close to the building (eight feet), that the doors of the building have to be closed all the time, on account of smells that are troublesome habitually. Many of the poor children attend here; and the janitor's work was recently so poorly attended to, that barefooted boys are said to have been tracked from the privies to the schoolroom by their wet feet.

The next building is a large brick structure of eight rooms, heated by indirect steam, and accommodating 360. The ventilation is considered good: there are sinks in the halls, two teachers' water-closets in the building, and privies outside. The privies in the yard are fair, but very cold. "Three cases only of scarlet-fever this term."

The next two are small schools, comprising four rooms each, and have nothing particular of note about them. The next, a brick building with four rooms, and a seating capacity of 224, has no ventilation except by the windows, and the privies, accommodating six on each side, are very filthy. The urinal is very poor; being a V-shaped trough of unpainted wood, only 12.5 feet from the building, and so near as to be at times troublesome in warm weather.

The next one is a wooden building accommodating 112. The sink-drain connection in the cellar is in very bad condition, and the privies are in the worst order of any yet seen.


STREET
BOYS YARD
STREET
PORCH
PRIVY, 10 SEATS
GIRLS YARD
SCHOOLS 10 & 65
0
10
20

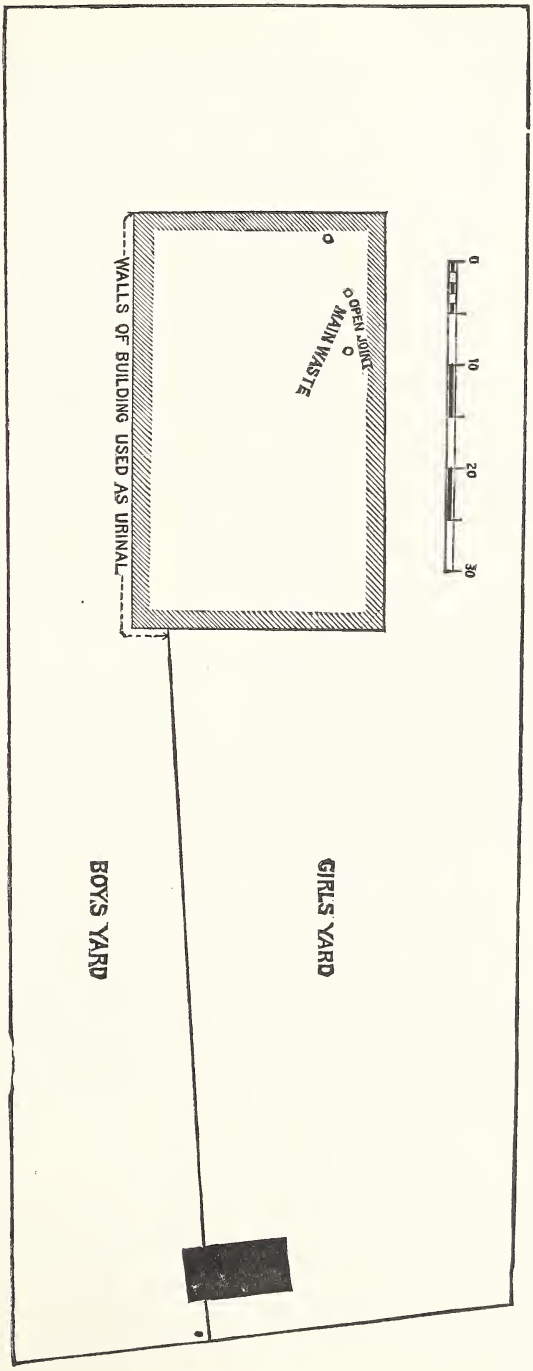
The rear of the building on the boys' side seems to be used as the common urinal; and on the side and front walls of the building were counted eight different places urinated upon, and wet at the time of inspection. It is stated that this was doubtless owing to boys from outside the school.

A school of two rooms is situated over a ward-room, is heated by stoves, and has poor ventilation. There is a trap, unventilated, at the sink in each room; and "no bad smells are noticed when the windows are open." The cellar is damp and close, yards cold and very contracted, and the boys' privy is in bad condition. It is hoped that this is only a temporary arrangement, as even if remodelled it would be very unsatisfactory: the lot is very small, and the yards cannot well be enlarged.

The High School contains 375 pupils, and they are not troubled with smells. The laboratory sink is without a trap: the urinals and water-closets are all in the basement, are not very nice, and quite dark. The main drain which runs under the cellar floor is open at one place, and there is an upward draught sufficient to blow out a candle.

Another school having 267 pupils, unventilated basement, water-closets under the hallways, and direct steam heat, is troubled with smells in the hallways after a rainy day and on Monday mornings. The water-closets are not tight, and the house-leaders stink from slip-joints. There is a cesspool in the yard, also, that is offensive; and the neighbors' privies are troublesome after a rainy day. The back pressure from the sewer seems to force the traps all over the building.

The Edson Schoolhouse is some thirty years old, has ten rooms, and accommodates about 500. There are nine privy-seats on the boys' side; and the girls' water-closets, in the basement, accommodate thirteen. Bad smells are noticed in the two rooms nearest the privies, particularly in the morning, stronger when the wind is from that direction, and in rainy weather more than dry. They are noticed all over the rooms, not in one portion only: the windows on that side cannot be opened. There was formerly an old vault immediately adjoining the building, and there is some question as to how thoroughly it was cleaned out and filled up. The cellar wall is loose, and it is perfectly possible for gas in any quantity to pass through: in fact, there have been puddles


0
10
20
30
OPEN JOINT
MAIN WASTE
WALLS OF BUILDING USED AS URINAL
GIRLS YARD
BOYS YARD

of water in that part of the cellar two and three inches deep.

Bartlett Schoolhouse is about as old as the last mentioned: it contains eight rooms and 420 pupils, direct steam-heat, public and well water. The ventilation of the building seems good. Sinks are the only plumbing except one hopper-closet in the basement, and the wastes run through the privies at the back. A public sewer is laid under the building to avoid a slight additional length; and peppermint introduced at the upper sink comes up through the cellar floor and through two surface-water cesspools in the girls' yard. The privies join the building, and together with the urinal, which is close by, necessitate the shutting of the windows; and there is so little care taken of the various conveniences, that the boys have urinated on the walls of the building within five feet of the entrance-door.

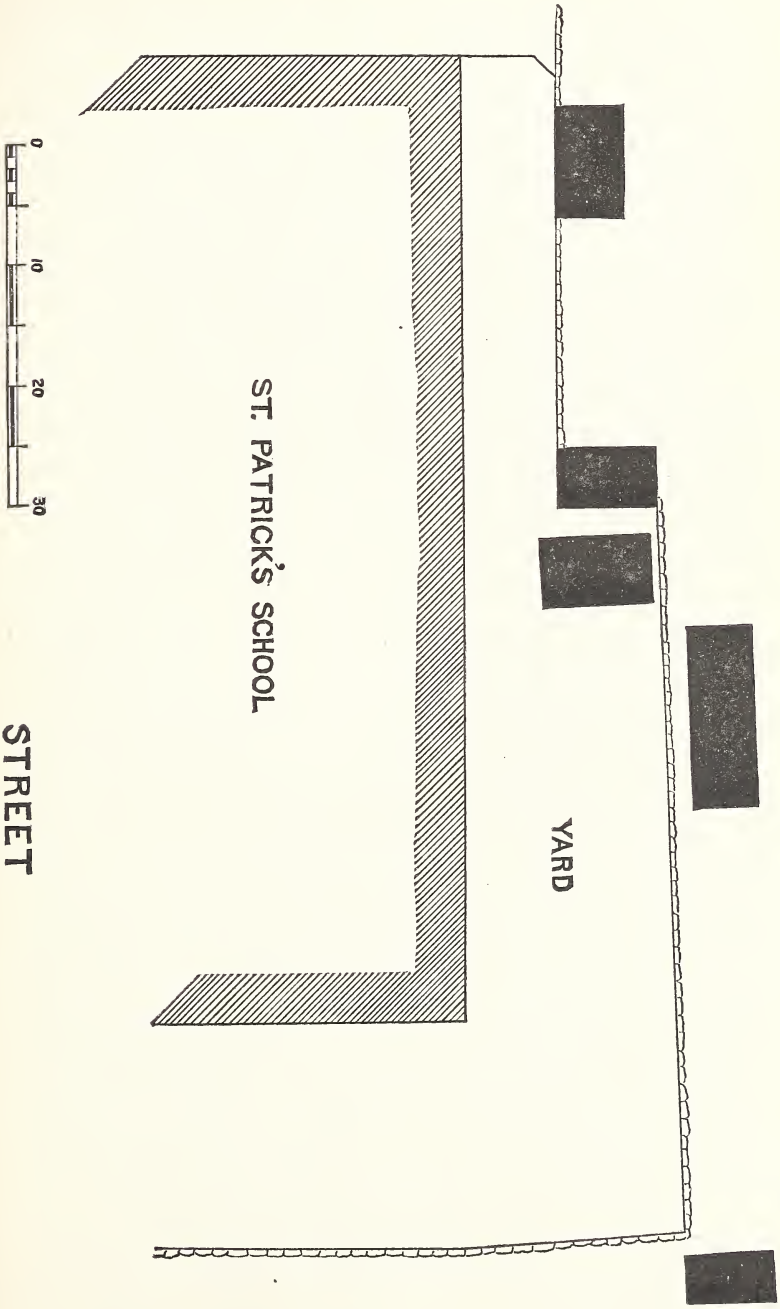
Moody School was apparently built about the same time as the Edson and Bartlett. The janitor's work of the building proper is better attended to than at either of the other two mentioned: the ventilation, however, is bad, dependence being placed only on windows. There is an opening in the main drain, which runs through the cellar, under the floor, to let surface water run off, from which opening there is an upward draught all the time. The boys' privies are very foul, and the urinal correspondingly bad. The boys evidently have lately (Oct. 27, 1880) used the corner of the outside door of the building.

Four schoolhouses near by are in very fair order: there have been no cases of sickness, and no bad smells.

Colburn School is in fair order; and there is no trouble from smells, though the ventilation is not very good. At the Ames School there is no urinal, and the privies are rather near the building. At Lyon-street School the urinal is in full view of the next house.

Parochial Schools.

St. Patrick's School is a remodelled church, not yet occupied (Dec. 21, 1880), containing ten schoolrooms and two halls, and is intended for boys only. The arrangements appear to be ample for lighting and heating (direct steam), and all the plumbing in the building is represented by one


0
10
20
30
ST. PATRICK'S SCHOOL
YARD
STREET

water-closet. The ventilation is questionable: the outside arrangements are such as to cause apprehension for the immediate future. The building is probably intended to accommodate 700 boys, if one may judge from the building of similar kind at Belvedere; and for these there is one four-seated privy (no urinal of any kind), facing and 2.5 feet distant from the brick vault of a tenement-house privy which stands on a higher level. A row of tenement-houses stands parallel with, and at a higher level than, the schoolhouse; and a bank-wall, some eight feet high, separates the two, with brick privy-vaults either forming part of the wall, or projecting beyond it into the school-yard. A glance at the accompanying plan will show the proximity of the privies to the windows, and how curtailed the yard-accommodations are. Two of the privies are within eight feet, and a third within eighteen feet, of the schoolhouse-walls, on a level with, and just above, the heads of children occupying the ground-floor rooms, and so close as to seriously affect the light. It is supposed that the tenement-house privies are used by about 200 people: at all events, if one may judge by appearances, they are much patronized, and not frequently cleaned out (it is doubtful how such an operation could be done without partial destruction of the buildings); and if their present condition and appearance is any criterion of their general state, it is safe to say that their walls are not water-tight, and that the overflowing of their contents is not an unheard-of occurrence. In justice to the parochial authorities, it ought to be understood that application has been made by them for partial abatement of the nuisances; but nothing has yet been done, and it is understood nothing is to be done at present. The second parochial school (Belvedere) is a mixed school, numbering 600 pupils, whose ages average twelve years, and is conducted in a new brick building 48.5 by 93 feet, erected for the express purpose. There is no cellar: the heat is by furnaces set in the basement, where there is also one large schoolroom. There are eight other schoolrooms, having windows on one side only; and the whole structure is intended to be of the best. Ventilation is insufficient unless the windows are open; and the only plumbing in the building consists of two sinks and four water-closets, all on the girls' side. The closets are of poor pattern, unven-

tilated, cold, and were not in good order at the date of visit (Dec. 21, 1880), although the building had been occupied less than four months. The soil-pipe is ventilated, and connects with the sewer, as do also the four house-leaders, which latter have loose joints about four feet from the ground, and smell badly. The arrangements on the boys' side consist of one faucet on the outside of the building, and a three-seated privy, less than 3.5 feet from the building, and directly facing it and the windows in the hallway. There is no urinal of any description. The privy is very foul already, and little attempt is made to keep it in order; while the walls of the building are used as a urinal. The land is graded very badly on the east and south of the building, so that surface and privy water has a direct tendency to run toward the building. The yard-room is so curtailed that no recess is given the children; and, though it is stated that there will probably be an additional privy provided for the boys, it is difficult to see how any structure of that character can be placed so near the school-building without, even with the utmost care, being a nuisance.

The third parochial school (St. Peter's), for orphan girls, occupies an old dwelling-house, partially remodelled and enlarged. Three schoolrooms accommodate 50 day and 60 evening scholars, whose ages are from six to fifteen years. There is a regular soil-pipe with water-closets, sinks, etc., in the house, and a privy outside, adjoining the dining-room. The privy has a ventilator just high enough to reach the level of the schoolroom windows on the next floor, and is so objectionable that the windows are obliged to be closed most of the time. The plumbing in the cellar is very poor and leaky, though it does not appear to be defective elsewhere. The building itself, although the furnishings are poor, is sweet and clean.

The select school, convent, and parochial school for girls, in charge of the Sisters of Notre Dame, is quite near the first-mentioned parochial school, and, in contradistinction to it, has good and commodious yards. There are ten schoolrooms, altogether: four in the select school, and six in the parochial, having a seating capacity of 516, the pupils varying in age from five to twenty-one years. In addition to the schoolrooms, there are dormitories, parlors, dining-rooms,

kitchen, laundry, etc. It rarely has been the case that a building has been visited where the whole premises are characterized by such exquisite neatness in every particular. From garret to cellar, kitchen, laundry, hallways, etc., are in as nearly perfect a condition as possible. All the plumbing, in every portion of the building (some of it in daily use for nine years), including lavatory with forty set basins, unventilated and poorly-trapped water-closets and bathrooms, is beautifully neat, and free from smell. The buildings and appointments are by no means perfect in primary arrangement; for there is standing water in the cellar after heavy rains. Heating is by furnaces and stoves intermixed; and though the ventilation by shafts in the select school is fairly satisfactory, in the parochial rooms there is absolutely no ventilation except by windows. The house-leaders run to the sewers, and are only partially tight. The kitchen is low-studded and unventilated; and in the yard at the back of the parochial school stands a large privy, with sixteen seats, outside, unfortunately, of the jurisdiction of the Notre Dame. The method of keeping good air in the parochial-school rooms is quite simple, but different from any thing that has been seen elsewhere. The rooms, six in number, have windows looking both east and west; so that in summer there is no trouble about getting a circulation of air through them. In cold weather, however, it is customary to pull down the upper sash of one of the windows for five minutes, every half-hour, the pupils in the immediate vicinity moving away temporarily. The windows are thus opened in succession; and the result is, that in spite of there being only stove-heat, and the rooms being crowded, the atmosphere is not close and disagreeable.

Of course it would be impossible for either public or private schools in general to exercise so much care as is manifested at Notre Dame. Who ever heard, for instance, of cleaning all floors and woodwork four times every day, and polishing once? It would be ridiculous to attempt it; but it shows clearly how much can be accomplished, when conveniences are not the best, simply by care, and may well serve as a proper rebuke to other schools where the sanitary accommodations are so little thought of or cared for.

It was found that well-water was freely used for drinking

(No. 1 particularly) in summer, as being cooler, and another well for cooking purposes (No. 2). For comparison, an analysis is given of Cochituate, made Oct. 27, 1875.

	Free Ammonia.	Albuminoid Ammonia.	Residue.		Total.
			Fixed.	Volatile.	
Cochituate . . .	0.0059	0.0197	3.04	1.14	4.18
Well No. 1 . . .	0.0016	0.0140	96.90	36.00	132.90
Well No. 2 . . .	0.0011	0.0168	93.10	10.80	103.90

The amount of chlorine in well No. 1 is 15.10, in well No. 2 is 15.90. Comment is unnecessary.

The condition of Lowell schools is rather discouraging; for there is a general lack of neatness in a majority of the buildings, or their surroundings, sometimes both, and scarcely any of them are precisely what one would wish to see. There are very few good water-closet arrangements in the buildings; and the outside privy conveniences are, many of them, scarcely fit for animals, much less for human beings. Taken as a whole, Lowell is below the average of other places visited.

Can any thing, in a small way, seem more disgusting than to find the side walls and the front doors of the school-buildings, and even the air-box of the furnace, used as common urinals? The best-arranged building in the world would soon become a nuisance from such use. A great proportion of the present dirty state of things may be entirely remedied by adequate and intelligent janitor-service. Very much of the discomfort and annoyance is due to careless maintenance, and might be almost entirely cured by soap and water.

Salem.

The State Normal School at Salem is in good order, except the heating; and that is such that in cold weather it is difficult to get the temperature above sixty degrees. The heat is by furnaces, which are old and inadequate. The plumbing is old-fashioned, and would scarcely be put in now, but seems to be tight and in fair order.

Holyoke Schools.[1]

Holyoke schools are unlike those of any other city visited, in quite a number of ways. In the city proper, but one building was found where the sanitary conveniences were not in the basement, and either part of or directly adjoining the playrooms. The buildings are all of brick, are furnished with city water, and supposed to be properly sewered; but the traps, so far as noticed, are none of them ventilated, and it is stated that the sewers are devoid of ventilation as well, so that it is questionable whether the arrangements operate as satisfactorily as they were intended to. In the city proper, there are nine schoolhouses, having forty-three rooms, and accommodating 1,973 pupils. In this place are to be seen, in rather an aggravated form, the difficulties of having both basement water-closets and playrooms. The janitor's work *is let out by contract*, from notions of economy (could any economy be more mistaken?); but, where so many people's comfort and health depend on the fidelity with which a man attends to the duty of properly cleaning the apartment in which so much time is passed every day, it is too great a risk to run. Especially does it seem unwise in a place like Holyoke, where complaint has been made, not once, but many times, of the imperfect condition of the sanitary conveniences.

One gratifying fact, of considerable importance sanitarily, was noticed in all the schools. There are in Holyoke a large number of French Canadians and Irish (see charts) mill-operatives and laborers, whose children have had no advantages of home training, and who are, therefore, naturally careless about the use of water-closets and privies, and for whom it is not uncommon, in other places, to provide outside accommodations, that are too apt to be both cold and dirty, on the plea that better arrangements would neither be appreciated nor properly used. But one closet out of sixty-two, comprising the total number in eight schoolhouses (water-closets, latrines, and hoppers), was out of order from any carelessness in its use, showing that at this place at least, — and the sanitary charts show that there is

[1] A collection of charts showing very concisely the results of a sanitary survey of Holyoke may be found on pp. 170–175 of this volume.

great filth in and around many of the houses of these people, — the poor children can and do take reasonable care of such arrangements; and nothing indicates that they naturally are not as capable of appreciating good accommodations as other children. It is true, that various single instances are reported, of total depravity, particularly in evening schools; but they are marked exceptions.

There is entire lack of either paint, shellac, or varnish, in the schoolhouse water-closets and urinals at Holyoke; why, is not known, unless it be supposed that unpainted wood be easier to keep clean. The urinals are none of them properly sheathed or flashed, there is little or no ventilation to any of the closets, and no attempt at any for the urinals, — possibly because the authorities believe such things cannot be kept from smelling.

The health records of the schools are very defective: none are regularly required of the teachers, and so no definite data can be obtained upon which to base opinions. Such records as have been received, from time to time, by the superintendent of schools, have not been kept; and literally nothing is *known* about the healthfulness, or otherwise, of any of the school buildings.

Springfield.

The city of Springfield is situated at the foot of, and on, a sandy hill on the east side of the Connecticut River, about midway between Boston and Albany. The outlook is north towards Mount Holyoke, and west and south-west towards the Berkshire Hills: there is a public water supply (Ludlow), and as satisfactory sewerage, perhaps, as one would expect to find in a city of 31,000 people.

In the Springfield Directory of 1880 is a tabular arrangement, giving the names of the schools, their number of rooms, etc., and the condition of the buildings. Under this heading are found the words "new," "good," "fair," "*old and bad.*" The two buildings to which "old and bad" are applied are Charles-street School and Bridge-street School. Fourteen buildings were visited here, including both Bridge-street and Charles-street; and though at the time the buildings were inspected there was no session, and therefore there could be no explanation from any teacher, yet it was easy to

see where the weak points in many of them were. No reports have ever been made from the schools, at any time. The health records, such as they are, have been kept since May 26, 1876; but they comprise only individual complaints, and records of the meetings of the board. The local Board of Health consists of three members, — the mayor, one alderman, and the city physician. Although the precise abilities of these gentlemen are unknown, and therefore unquestioned, it would seem scarcely likely that a mayor and alderman should be chosen on account of their capacities as health officers; yet, unless such be the case, how can a health board so constituted be capable of properly attending to the duties which belong to it, — unless, indeed, all work be left to the city physician?

The school-buildings here are mainly well constructed, and the janitor's work seems fairly attended to. Most of the buildings are supplied with the city water, although some of them supplement it with wells. Charles-street School is properly described by the words "old and bad," although "dirty" might have been added with perfect truth. It is a wooden building containing five rooms, only three of which, however, are occupied. The ventilation is by hot flue from the stoves which heat the rooms, and is said to be very satisfactory. There is only one sink (untrapped) in the building; water is kept in pails in the rooms; and they are not troubled by smells, though there are six privies at the rear of the building. The cellar is under a part of the building only, and is dirty. In fact, although the accommodations are mainly old-fashioned, it seemed from a single visit, and without consultation with the teachers, as if soap and water, supplemented with a little paint and varnish, would make the entire building much more comfortable, and remove both "bad" and "dirty" from the list of epithets that properly belong to it at the present time. Bridge-street School is just as old-fashioned, but cleaner, except as concerns the privies. It seemed likely that there might be water in the cellar at times, though there was no direct evidence of it at the date of visit, Jan. 15, 1881. The heat is by both furnace and stoves; ventilation is poor; and water is brought from a sink in the cellar, and kept in pails in the rooms. The privies are both foul in condition, and poor in construction.

Oak-street Primary School, which ranks as "fair," really needs attention quite as much as Charles-street, and more than Bridge-street. It is in a brick building heated by two furnaces, with standing water, at times, in the cellar. There is a faucet, for drawing water, in the basement, but no waste for it; the sinks in the building have pails underneath to catch the drip, and there appears to be no waste-pipe of any kind running from the building. Privies are back of, and quite near, the building, and are not in very nice condition. Additional janitor's work everywhere would be an antidote to a large portion of the trouble.

Oak-street Grammar School is in a large brick building, containing nine rooms and a hall, heated by both steam and stove. The ventilation is fair, leaders deliver on the surface of the ground; drinking-water, both city and well, is kept in pails in the rooms. There are eight sinks, which empty into a cesspool in the basement of the building. A water-closet is now being put in for teachers' use, into which it is intended to conduct sink-wastes and leaders; but the plumbing is faulty in execution. The well is in the cellar, twenty-five feet from the cesspool; though, as the latter is supposed to be used for clean water only, it is probably not harmed from that source. It is covered with flagging, but is lower than the surrounding cellar floors, so that any washing-water used on the latter must gravitate towards the well. The privies are brick structures, accommodating twenty, are in the yard, and fairly ventilated, and, excepting the boys' urinal, are in good order. It seems as if it would be wiser not to use the well-water.

Central-street School, nine rooms and one hall, is heated by indirect steam, and the ventilation is good. The seven sinks and bowls in the building are untrapped, and there is one water-closet in the building. The privies, of brick, are reasonably clean; the urinal, which is nearly new, is poor. There seems to be both public water and well-water used, as there are pumps in both sides of the basement.

York-street School is in four rooms of a furnace-heated brick building, where there appears to be fair ventilation, and where the water (spring) is kept in pails in the school-rooms. There is one sink in the building, with no waste; privies are outside; there is no urinal, and it is really a

country school. The cellar is not specially good, for occasionally there is standing water; but the janitor's work seems fairly well done, and the building is clean.

West Union-street Schoolhouse, of wood, is heated by two furnaces: there are brick privies at the rear and within twelve feet of the building. There is no ventilation of the building: two basement sinks represent all the plumbing, though on the first floor there is a movable wash-stand.

Court-street Schoolhouse is of brick, and does not vary specially from the others. There are four rooms, heated by both furnaces and stoves, two untrapped sinks, three pan-closets on the girls' side of the basement, unventilated, cold, and not very nice: the boys' privy, on the north of the building, is nasty, and there is no ventilation for it.

Elm-street Schoolhouse is a large brick building, where there are eleven sinks and one water-closet. The privies are eight feet from the building at the rear, in a brick structure, with ventilation that comes just on a level with schoolhouse windows. They were built a year ago, and are in very fair order, except the boys' urinal, which smells from lack of care.

At East Union-street School the boys' privy is foul, that of the girls is in better order, but neither is properly ventilated.

School-street School has but one room: it seems sweet and clean, and the privies are in good condition.

Hooker-street School is in a large eight-room brick building. There is a faucet with public water in each schoolroom; house-leaders empty into the sewer, and there is one pan-closet and one sink in the building. The only curious thing noticed was the arrangement of trapping (?) the bowls from the schoolrooms, where the overflows from cylinder traps are made in the *bottoms* of the traps, thereby apparently ruining the purpose for which they were intended. The privies outside are moderately clean, but exceedingly cold.

Worthington School occupies a brick building containing eleven rooms. There are five bowls and two sinks in the building; and the water-closets and urinal are all in the basement, well put together, but unventilated. As a consequence, the urinal is a great nuisance, not only in the basement but elsewhere. The girls' water-closets are in good order; though at the date of visit one of the supply-pipes had burst (?), and was leaking badly.

The High School is in a comparatively new brick building, heated by steam, and having basement water-closets, eleven on the girls' side, and ten on the boys, and in addition thirteen urinals. The latter, as usual, smell somewhat; but the closets are in better order than those on the girls' side, where lack of proper ventilation doubtless makes things worse. In addition there are laboratory sinks, seven set bowls, and two water-closets in the entresol; these last not being ventilated in the least, and not throwing sufficient water.

The impression left after inspection of Springfield schools is, that the error of having basement closets appears to have been found out, as they are being removed, and outside ventilated privies substituted, precisely the reverse of what is going on at Holyoke; that both public and well water is used in many of the buildings; that lack of proper ventilation is not infrequent, and heat deficient; but that additional janitor's work would to a great extent obviate existing evils, and render the school-buildings much more comfortable than at present.

	Number of Rooms.	Seating Capacity.
Charles-street School	5	259
Bridge-street School	3	157
Oak-street Primary School	4	184
Oak-street Grammar School	9	445
Central-street School	9	447
York-street School	4	183
West Union-street School	4	220
Court-street School	4	231
Elm-street School	13	640
East Union-street School	4	203
School-street School	1	90
Hooker-street School	8	438
Worthington-street School	11	474
High School	–	422

Recommendations.

The materials of which school-buildings are constructed are of little consequence: stone, brick, or wood will answer equally well, if properly put together. The cellar or basement should be dry, have a concrete, brick, or flagging floor, and may in rainy weather be used as playroom.

The schoolrooms and halls should be well lighted, and not too high, as such rooms necessitate longer stairways, additional heat, and greater first cost and maintenance. Rooms are seldom seen where a stud of over twelve feet is advisable, and frequently much less will answer the purpose better. All plumbing should be as simple as possible, where it can be seen, and be easily accessible for repairs at any time, without disturbing the regular work of the school. All wastes should be trapped, and as near their source as possible. It seems as if it ought not to be necessary to reiterate so frequently the fact, that, though bowls and sinks may be only *intended* to put clean water down, yet it remains true that they are, and always will be, occasionally used for other and consequently improper purposes. It is insufficient to have an unventilated S-trap as much as even one hundred feet from the bowl, which may answer for half a dozen different water-fixtures: *every* fixture should have its own trap, and one that cannot be siphoned.

It is an open question whether basement water-closets and urinals are desirable adjuncts, at any time, to a building; and playrooms in the same apartment as the closets should never be allowed, under any circumstances. In point of fact, the cellar or basement is an unfortunate place to locate such conveniences; for, no matter how carefully arranged, ventilated, and maintained, there are times when there must be more or less smell noticed on the floors above.

It is true that instances have been noticed where there is, at the present time, no trouble whatever; but five or ten years hence, when the closets have been used considerably longer than now, there may be a different story to tell; and at any time the proper care of such things in the basement is too great a responsibility to leave to the janitor. Basement-kitchens are apt to be troublesome, by causing other parts of the house to smell unpleasantly of the cooking; schoolhouse basements are frequently heated either by steam or furnace, and there is no reason, therefore, why smells may not be carried over the schoolhouses. In point of fact, they are so carried. Omitting, for a moment, the question of nuisances, it is well understood, that, between the ages of thirteen and twenty, girls ought not to go up and down stairs more than is necessary; yet in school-architecture

this seems to be rarely considered, for we find school after school in great three and four story brick buildings, where not only are all water-closets in the basement, but pupils are obliged to go down stairs to get water to drink, or use for other purposes. Urinals create most of the smell that is usually attributed to water-closets, and in almost every case a smell is due largely to lack of janitor's work. It is a popular fallacy, that such places cannot be kept clean and free from smell. People who really believe this to be a fact should visit the Boston and Providence Railroad Station in this city, or Young's Hotel, or the Massasoit or Cooley's at Springfield, either of the first two probably having ten times the use of any school conveniences, day and night, week in and week out, year after year, and it will be found that they are not nuisances; that, though there is frequently no special provision made for ventilation, the condition of the closets and urinals will be found *good;* they do not *smell* appreciably, and it is largely owing to careful maintenance. Water-closets and urinals should all be in a tower at one end of the building, warmed, having outside windows, and separate ventilation. Closets should be on every floor, for the girls at least: usually it can be arranged without trouble for both girls and boys. When privies are used at all, they should be so far removed from the building, as never to be noticed at open windows; and, where the limits of the yards are so curtailed as to render this impossible, the janitor's work should be excessive, both in quality and quantity. Privies in yards are not desirable at any time, and should not be continued, unless the school be small, and there be lack of running water. It is not always safe to argue, that, because privies used by twenty-five people are not terrible nuisances, four or five times that number of people can use them with no worse results; yet that appears to be quite generally taken for granted. The method of warming schoolhouses has not yet reached perfection; though indirect steam-heat — that is, where the radiators are all boxed up at or near the ceiling of the basement, and currents of outside air are passed through the radiators, and then up into the rooms and hallways — is thought to be the best devised. In cold weather, however, it is almost a universal custom to use "cellar air," instead of that from outside; the reason assigned

being, that it is impossible to properly heat the outside air, and supply a sufficient quantity, at the right temperature, in the rooms. In many cases it would be far better to use the poorest pattern of old-fashioned air-tight stove, than the cellar air. Next to indirect steam, in point of efficiency, are furnaces; and, where properly managed, they are capable of giving very good satisfaction.

Next to furnaces may be reckoned direct steam, where the same air is heated over and over again; and next to that, again, stoves. Open fires, of course, are the best of all, but are presumed to be entirely out of the question on account of cost.

Ventilation seems to be hardly sufficiently well understood; and it would be difficult to say with any degree of certainty that any one of the numerous plans, proposed or introduced, can be considered as thoroughly satisfactory for every building. Moreover, a system which furnishes plenty of fresh air must of necessity be wasteful of heat; and it is very evident that none of the buildings visited, when piped for steam or furnace, had satisfactory calculations made for what may be termed ventilation waste.

Air-boxes for both indirect steam and furnaces almost universally terminate on the level of the ground, and are the size and shape of one or more basement windows. They are very apt to catch all the dust and dirt that is blowing about; sometimes they are directly opposite to, and only a few feet from, the privies; and in more than one instance it has been found that they are thoughtlessly used as urinals by some of the boys. If, instead of terminating in this way, they be carried up a few feet above the ground, and be made of metal instead of wood, these objections will be entirely removed.

The question of what light is best for children to study by, is now receiving a great deal of consideration; and several new schoolhouses are being put up having light on one side only, or both sides, but none at the back or front. It is too early yet to determine just what the net result will be; but it is reasonable to suppose, that, though the light may be better, the ventilation, particularly in summer, will probably not be improved.

It is not possible to draw a definite line when well-water

can, and when it cannot, be safely used: the conditions would vary with every building, and every town and city. It would be better, therefore, wherever there is a public water-supply, to depend on that. Certainly it is unwise to use well-water for a short time only in summer; for, if used at all, a well should be kept in constant use.

HEALTH OF TOWNS.

EPIDEMIC IN ADAMS.

BY

J. F. ALLEYNE ADAMS, M.D.,
OF PITTSFIELD.

SANITARY CONDITION OF HOLYOKE.

BY

E. W. BOWDITCH, C.E.

NEGLECT OF VACCINATION.

BY

Z. B. ADAMS, M.D.,
OF FRAMINGHAM.

THE EPIDEMIC AT ADAMS, IN JUNE, 1880.[1]

On the 15th of June, 1880, and during the few days following, a large number of persons in the town of Adams were sick with cholera-morbus. The attacks came on suddenly, were of short duration, and none were fatal. The symptoms consisted, in most cases, of vomiting, diarrhœa, and pain in the stomach and bowels. Some had not more than one of these symptoms; others had, in addition, coldness of the extremities, faintness, and cramps in the bowels and legs. Those first attacked sent promptly for medical aid; but, their symptoms speedily yielding to mild remedies, people generally found such assistance unnecessary, and not one in twenty was seen by a physician. The largest number of attacks occurred in the evening or night of June 15; on the morning of the 16th some alarm prevailed; but, the mild character of the sickness being soon discovered, all fear subsided. By the 19th the epidemic was practically over.

As for the cause of this singular outbreak, none was apparent. Of the various theories prevailing in the town, none was proved; and therefore, with a view to determining, if possible, the exciting cause, the present investigation was instituted.

Adams (until recently known as South Adams) is a manufacturing town in the northern part of Berkshire County, bounded by North Adams on the north, and Cheshire on the south. The Hoosac River flows in a northerly direction through the centre of the town, furnishing water-power to several great factories, the source of the town's prosperity. The general surface of the town is hilly. The valley of the Hoosac is very narrow in the southern part, the hills rising abruptly on either hand, leaving but a few rods of level

[1] In the preparation of this report, the writer is indebted for much valuable assistance to Dr. H. M. Holmes of Adams.

ground. At Maple Grove the valley widens out, and attains a breadth at the business centre of about a mile. The chief centre of population is the village of Adams, lying on both sides of the river about the centre of the town, and including within its limits several large factories. Smaller villages are clustered about the factories north and south of this point. A sparsely-scattered farming population occupies the hill-country. There are no swampy lands in the town; the current of the river is rapid, its bed stony and free from mud, its water clean and transparent. The mill-ponds are narrow and deep. The soil is a porous gravel, which readily absorbs all waste water, sewers not being in use.

The water-supply has, for five years past, been derived from a small reservoir among the hills at Cheshire Harbor, in the town of Cheshire, close to the Adams line. This water has been noted for its purity; and, since its introduction, typhoid-fever has been practically unknown. The town is, and has been, a remarkably healthy one, and has enjoyed a peculiar immunity from epidemic diseases.

On the 18th of June, the third day after the outbreak, the reservoir was visited by the selectmen, water-commissioners, physicians, and other citizens. The water was found perfectly clear and clean. The reservoir is two or three acres in extent, and averages ten or twelve feet in depth, and its waters are so transparent that the bottom may be seen in every part: it is fed by a mountain brook. Immediately above the reservoir are an old dam and disused saw-mill. The only impurities that could be found were a mass of leaves and sticks collected about this dam: no dead fish or other animal matter could be found. Samples of water were taken from the reservoir, the brook above, and from a faucet in the town, and sent to Professor Wood for analysis, with this result: —

	No. 1. Brook.	No. 2. Reservoir.	No. 3. Pipes.
Ammonia	.0107	.0080	.0107
Albuminoid ammonia	.0080	.0080	.0080
Chlorine	.266	.247	.21
Fixed residue	2.9	2.8	2.4
Volatile residue	1.3	1.5	.8
Total residue	4.2	4.3	3.2

This analysis shows the water to be of very great purity.

The following information concerning the water-supply has been furnished by Mr. C. A. Waters, superintendent of the water-works of Adams, in reply to questions: —

"Capacity of reservoir, about 8,000,000 gallons. Average daily consumption, 3,000,000 gallons.

"On June 14 the water was drawn out of the pipes, for the purpose of repairing, and making connections.

"When again let on, the water was, as usual under such circumstances, milky, from admixture of air, but not otherwise changed.

"In making joints on the main pipe, no red nor white lead was used. Pig-lead is melted, and poured into the joints, and then driven in hard, making them water-tight.

"On examination of the reservoir, no dead animals, nor decaying matter of any kind, excepting leaves, could be found in the reservoir, nor any of the streams which feed it; though every stream was explored to its fountain-head."

The weather had been unusually hot for several days previous to the 15th; and on that day there was a fall in the temperature, the evening being damp, foggy, and oppressive, and with a peculiar smell in the air, described by Dr. Holmes and others as like that of a swamp.

Mr. W. P. Kendall, a medical student, was employed to canvass the town for details of the epidemic, and for facts which might lead to the determination of the cause. By this means a mass of statistics was obtained, from which are deduced the following results: —

The canvasser found, in the houses visited, a population of 4,634, being about 1,000 less than the figures of the United-States census taken shortly before, which showed a population for the town of 5,638. The houses omitted were partly in the remotest out-lying districts, and some about the factories, whose occupants could not be found, or, being Canadian French, could not be understood. The little village of Cheshire Harbor, lying partly in Adams, but chiefly in Cheshire, was included in the investigation, as this was the most southern point visited by the epidemic.

The total number of sick was found to be 1,112, or 23.9 per cent of the people seen.

Age. — As to age, the cases were distributed as follows: —

Age.	Population.	Number Sick.	Per Cent.
Adults	2,953	831	28.1
15 to 10	540	139	25.7
10 to 5	561	75	13.3
Under 5	580	67	11.5
Total	4,634	1,112	23.9

This table shows that the largest proportion of sick were adults, and that children were affected in a ratio irregularly diminishing with age. The most marked difference is between persons over ten, and those under ten; 27.7 per cent of the former being attacked, to 12.4 per cent of the latter.

Date of Attack. — The following table shows the date of attack in 898 cases in which the date could be ascertained: [1] —

Date of Attack.	Renfrew.	Gingham.	Adams.	Maple Grove.	Arnoldville and Cheshire Harbor.	Suburbs.	Total.
June 13	–	2	5	2	–	–	9
14	–	1	8	–	–	–	9
15	33	81	368	84	38	32	636
16	2	24	93	13	3	1	136
17	–	5	32	3	2	4	46
18	–	6	20	1	1	2	30
19	1	4	2	4	1	–	12
20	–	1	5	–	–	–	6
21	1	–	3	–	–	–	4
22	–	5	3	1	1	–	10
Total	37	129	539	108	46	39	898

From this table it appears that 636 persons, or 70.8 per cent of all in which the date was ascertained, were attacked on June 15, and that 772, or 85.9 per cent, were attacked on either the 15th or 16th. In all the districts, the 15th is seen to be the day when the greatest number of attacks occurred.

[1] For the purposes of this investigation, Renfrew is assumed to include all factory-grounds north of the gingham-mill, and also to include the lime-kilns. The gingham-mill is made a separate district, on account of the peculiarity of its water-supply. Adams means the centre village. Maple Grove is a distinct group of buildings. Arnoldville and Cheshire Harbor are so nearly contiguous, that they are here classed as a single district.

Duration of Attack. — The following table shows the duration of the sickness in 898 cases: —

Duration of Attack.	Renfrew.	Gingham.	Adams	Maple Grove.	Arnoldville and Cheshire Harbor.	Suburbs.	Total.
1 day	25	65	234	57	21	20	422
2 days	4	27	140	25	18	7	221
3 "	5	14	66	14	1	4	104
4 "	1	4	24	4	1	3	37
5 "	–	5	16	–	–	–	21
6 "	–	–	2	–	–	–	2
7 " or about a week	–	10	46	6	3	2	67
Over a week	2	4	11	2	2	3	24
Total	37	129	539	108	46	39	898

From this it is seen that 422 persons, or nearly half, were sick one day; 221, or one-fourth, two days; and 104, or one-eighth, three days. The number sick not more than three days was 747, or 83.1 per cent of the whole.

Drinking-water. — The reservoir-water is supplied to all the villages in the valley of the Hoosac, from Cheshire Harbor on the south to Renfrew on the north. A small private reservoir supplies the tenement-houses on the Gingham ground, though the factory and schoolhouse are supplied with the public reservoir-water. Well-water is used by some families in all parts of the town, and spring or brook water by a few. To ascertain what water had been used for drinking by each person, was a difficult matter, as many have one kind of water at home and another at their place of business or work. The inquiry was made, however, as carefully as possible, and with the result shown in the accompanying table: —

Drinking Water.

	Reservoir.			Well, Spring, or Brook.			Reservoir and Spring, etc.			Company Reservoir.			Company Res. and Reservoir.		
	Sick.	Not Sick.	Per Cent.	Sick.	Not Sick.	Per Cent.	Sick.	Not Sick.	Per Cent.	Sick.	Not Sick.	Per Cent.	Sick.	Not Sick.	Per Cent.
Renfrew . . .	37	155	19.2	8	61	11.5	6	32	15.7	–	–	–	–	–	–
Gingham . . .	47	172	21.4	–	59	–	–	–	–	32	152	17.3	62	449	12.1
Adams . .	491	881	35.7	28	308	8.3	125	263	32.2	–	–	–	–	–	–
Maple Grove . .	100	214	31.8	11	114	8 8	24	36	40.0	–	–	–	–	–	–
Arnoldville and Cheshire Harbor .	19	41	31.6	6	60	9.0	33	75	30.1	–	–	–	–	–	–
Suburbs . . .	21	16	56.7	10	321	3.0	14	14	50.0	–	–	–	–	–	–
Total . . .	715	1,479	32.5	63	923	6.3	202	420	32.4	32	152	17.3	62	449	12.1
	2,194			986			622			184			411		

This table shows that of the 4,497 persons whom it represents, 2,194, or nearly one-half, used only reservoir-water, and that of these 715, or 32.5 per cent, were sick. The largest percentage of sickness among these, viz., 35.7 per cent, was in Adams Village; and the smallest, 19.2 per cent, at Renfrew.

The number of persons using only well, spring, or brook water was 986, of whom 63, or 6.3 per cent, were sick. In this class the percentage of sickness varied but little on the line of the river, ranging from 8.3 to 11.5; while in the suburbs it was only 3 per cent.

The number using both well and reservoir water was 622. This class includes many who had access to both kinds of water, and could not remember which they drank. It is probable that they nearly all drank reservoir-water. Of these, 202, or 32.4 per cent, were sick; being almost exactly the same proportion as of those using only reservoir-water. The smallest proportion was 15.7 per cent, at Renfrew; while in the village of Adams it was 32.2 per cent. At Maple Grove and in the suburbs it was 40 and 50 per cent respectively; but the numbers in both places were too small to give any reliable proportion.

The statistics of the Gingham ground show, that, out of 873 persons, 219 drank only reservoir-water, and that of these, 47, or 21.4 per cent, were sick; 59 drank only well or spring water, and of these none were sick; 184 drank only company-reservoir water, of whom 32, or 17.3 per cent, were sick; and 411 drank both company-reservoir and reservoir water (this class including many who had access to both kinds of water, and could not remember which they drank), of these 62, or 12.1 per cent, were sick.

Milk. — The source of the milk used was ascertained in the case of 850 families. The subjoined table shows how many families had sickness, and how many did not, who took milk from each of the six dealers, and also those who had a private supply.

Milk.

DEALERS.	Renfrew.		Gingham.		Adams.		Maple Grove.		Arnoldville and Cheshire Harbor.		Suburbs.	
	Sick.	Not Sick.	Sick.	Not Sick.	Sick.	Not Sick.	Sick.	Not Sick.	Sick.	Not Sick	Sick.	Not Sick.
J. H. Fisk	–	–	–	–	49	25	24	19	11	3	4	–
Bucklin	1	–	20	34	61	27	1	–	–	–	–	–
Howland	1	3	9	5	20	28	3	1	1	–	–	–
Burt	4	4	24	28	27	13	–	–	–	–	–	1
Anthony	–	–	11	11	5	12	1	2	1	–	–	–
Bryant	–	–	–	–	–	–	–	–	6	10	–	–
Private	18	16	16	13	106	62	31	15	3	4	23	49
	24	23	80	91	268	167	60	37	22	17	27	50

The following table shows the source of the fresh *meat supply* for 850 families: —

BUTCHERS.	Renfrew.		Gingham.		Adams.		Maple Grove.		Arnoldville and Cheshire Harbor.		Suburbs.	
	Sick.	Not Sick.	Sick.	Not Sick.	Sick.	Not Sick.	Sick.	Not Sick.	Sick.	Not Sick.	Sick.	Not Sick.
Tucker	8	4	22	34	76	26	2	–	–	–	8	8
Taylor & Thompson	14	15	35	27	74	30	6	5	1	–	3	6
McAnanny	–	–	3	1	36	32	18	12	9	6	4	–
Beers	1	–	5	4	10	7	19	12	7	10	–	–
Private	–	4	1	2	22	20	6	2	1	1	12	25
	23	23	66	68	218	115	51	31	18	17	27	39

The only ice used in the town was cut from the town-reservoir. As the water had been used for drinking with perfect impunity at the time the ice was cut, it was not deemed necessary to make a special investigation of the subject. Inquiry was made, however, as to whether or not ice-water had been used; but the result was wholly negative.

To ascertain what had been the exact diet of each person immediately previous to the epidemic, was not easy, nor indeed possible; but most families could remember whether or not they had certain common articles of diet, as is shown below.

	Families Sick.	Families not Sick.	Per Cent.
Salt pork	57	79	41.9
Beefsteak	218	129	62.8
Fresh vegetables	33	19	63.4
Ham and eggs	37	20	64.9
Strawberries	126	67	65.2
Fish	14	7	66.6
Veal	29	8	78.3
Corned Beef	28	5	84.8

This table shows that diet exerted no marked influence upon the sickness. By many, strawberries were at first thought to be the exciting cause; but the table indicates that families who partook of this fruit were not specially affected. The same is true of fresh vegetables, which had then just come into the market, and might be susceptible of suspicion.

Savoy. — It having been currently reported that the epidemic prevailed simultaneously in the town of Savoy, adjoining Adams on the east, that town was visited and canvassed. Nine cases were found to have occurred in that town. Four of these were attacked on June 15, one on the 16th, and four not until the following week. All of those attacked on the 15th and 16th had visited Adams the previous day. Three of these are known to have drank reservoir-water while there. The others could not remember what they drank. Of the four attacked the next week, one had been to Adams, and three had not. This seems to indi-

cate that the cause of the sickness in those attacked on the 15th and 16th is to be sought in Adams and not in Savoy.

Other Towns. — It was also reported at the time that the sickness prevailed in Windsor, the next town south of Savoy and nine miles from Adams; but it was found, on visiting the town, that there were no cases there. By inquiry of the physicians of North Adams, Williamstown, and Cheshire, all contiguous to Adams, it was found that neither of them was visited by the epidemic; nor has it been heard of elsewhere.

From the foregoing analysis, it is evident that the epidemic cannot be traced to milk, meat, or any other article of food. The evidence against the reservoir-water, however, is sufficiently strong to attract attention.

The reasons for suspecting the reservoir-water are these: —

1st, The epidemic was limited to the districts supplied from this reservoir, viz., Cheshire Harbor, and the valley of the Hoosac in Adams. In the outlying districts, of three hundred and twenty-one persons who drank only well, spring, or brook water, only ten were sick; while of thirty-seven who had been to town, and drank reservoir-water, twenty-one, or more than half, were sick.

2d, In all parts of the town it was found that a much larger percentage of sickness occurred among persons using only reservoir-water, than among those using well or spring water; being on the average 32.5 for the former and 6.3 for the latter.

3d, As many as forty-one persons stated that the water tasted or smelled badly.

4th, The symptoms were such as are generally produced by some article of food or drink, and no evidence can be found against any such article except the water.

The arguments on the other side are these: —

1st, Of persons using well, spring, or brook water, although the proportion was small, yet no inconsiderable number (63) were sick. Of these many were very intelligent people, whose statements carry weight. Several were positive that they drank no water, whatever, on the day of the outbreak.[1]

[1] Some allowance will have to be made in all the statistics for imperfect memory. A month had elapsed between the epidemic and the making of

2d, The number of persons who said they noticed a smell or taste in the water is very small, compared with the whole population; and all the rest, including the most intelligent citizens, deny that any such smell or taste existed.

3d, The analysis of the water, three days after the outbreak, showed it to be free from impurity.

4th, The water has been in constant use, and no such effect has ever resulted, either before or since the outbreak.

One of the most puzzling parts of the inquiry is concerning the Gingham grounds, where it appears, that, of those using only the company-reservoir water, as many as 17.3 per cent were sick, not much less than the 21.4 per cent of those in the same district using only reservoir-water; and yet, among the fifty-nine using only well or spring water, not a single case occurred.

The statistics of this district are probably less reliable than of any other; since all the mill-operatives and school-children had access to both kinds of reservoir-water, and to remember which they had used for drinking, at a time when public attention had not been called to the subject, must have been almost impossible. These people too were mostly foreigners.

If the water did cause the sickness, it must have been by reason of some temporary impurity, which in a few hours passed through the pipes and disappeared. What this impurity may have been, it is impossible to say; since the water, when examined, was found perfectly pure. Some putrescent animal substance, if in considerable quantity, might have caused it; but no trace of any such thing could be found in the pond. Paris green was suspected; but on inquiry it was found that only one small field of potatoes lay near the reservoir, or the brook feeding it, and that to these no Paris green had been applied. An attempt to trace the cause to the shutting-off of the water on the previous day proves equally fruitless. The superintendent

these inquiries. In the mean time, people had had time to forget, or, what is worse, to have their memory aided by a theory or opinion. This was often apparent in the course of the investigation. For instance, one man who had been sick stated very positively that he had drank no reservoir-water on June 15. Afterwards two of his acquaintances said that they saw him drink it on that day. Two others who were certain they drank only well-water on that day, afterwards discovered, by inquiry, that what they supposed was well-water was drawn from the reservoir supply.

says that only metallic lead was used in making connections on the main pipe, and that it was impossible for any poisonous substance to get into the pipes at that time. The impurities which adhere to the inside of pipes, especially near the "dead ends," usually render the water turbid when first let on after being shut off; but this is immediately washed out, and people would seldom attempt to drink water so discolored. Moreover, such an impure condition was observed but by very few persons; and the general testimony was that the water appeared pure. The milky appearance, from admixture of air, could have no possible effect.

If the reservoir-water be eliminated as the cause of the epidemic, it only remains to believe that the cause was atmospheric. That this might have been the case, may be argued from the facts: —

1st, That there had been a sudden change in the weather on the day of the outbreak; the high temperature which had prevailed for some days having given place to a much lower one, and the night of the 15th being damp and foggy.

2d, That a peculiar smell was observed in the atmosphere on the night of the 15th. This was testified to by Drs. Holmes and Burton, who were out all night, attending upon the sick.

But it may be said, in opposition to this theory: —

1st, That the same change of weather occurred over a large extent of country, and that the sickness did not occur elsewhere.

2d, That no poisonous miasm could have arisen from the river; since its water was pure, its bed clean, and free from sediment. There were quite as many cases, also, in the higher as in the lower portions of the town.

3d, That no swampy or unwholesome lands exist in the vicinity of Adams. The only body of water in the vicinity is the Cheshire reservoir, four miles away to the south, which was at that time full of water, and with no wet lands on its borders.

4th, That the symptoms were not such as are apt to be produced by atmospheric causes. Cholera-morbus, it is true, usually occurs in hot and sultry weather, or after a change from this to cooler weather; but its occurrence as an epi-

demic, and a strictly localized one, when the same influences are wide-spread, is something hitherto unknown.

Conclusion.

The results of this investigation may be briefly stated thus: —

The evidence throws suspicion on the reservoir-water; but that this was the cause of the sickness is by no means proved, and must be considered doubtful.

The cause, whatever it was, was temporary in its operation, and not connected with any condition which has at any other time impaired, or is likely to impair, the healthfulness of the town of Adams.

SANITARY CONDITION OF HOLYOKE.

BY

E. W. BOWDITCH, C.E.,
BOSTON.

HOLYOKE

1880.

SCALE 500 1000

- ○ *Some Sickness*
- ● *Scarlet Fever*
- ■ *Typhoid Fever*
- ▲ *Other Zymotic Diseases*

FIRST LEVEL CANAL

SECOND LEVEL CANAL

THIRD LEVEL CANAL

SECOND LEVEL CANAL

CONNECTICUT RIVER

1 2 3 4 5 6

SANITARY CONDITION OF HOLYOKE.

Holyoke has now a population of nearly 22,000, and is one of the most rapidly growing of our manufacturing communities. Situated on the west bank of the Connecticut River, it is extending in all possible directions, — north-west, west, and south-west. Originally, the country was pleasantly rolling, and there were fine forest trees, and charming views; until the mistaken idea was introduced, that, to be economical and convenient, all streets must be arranged in rectangular manner, and that a regular slope rising westward from the second level canal would produce the acme of beauty. Thousands upon thousands of cubic yards of earth were moved, most of the forest-trees cut down, and, as a result, a perfect desert now occupies much of what might have been a very pleasant and attractive town. Had it been an economical development, it would have that redeeming feature; but, to produce this result, much money was expended, and as one consequence, in summer, clouds of dust envelop the city from end to end. The sanitary survey was confined to six wards of the city; the seventh being so sparsely settled, that for the purpose of this survey it belongs to the city only in name. The results, shown graphically for each ward, and finally for the six wards together, include statistics for 3,160 families, representing some 18,000 persons, and answer nearly 42,000 questions. As the charts are self-explanatory, it will only be necessary to state that each circle represents one hundred per cent of whatever it is intended to explain; and the sectors of the circle shown are, in every case, the true result derived from the original memoranda. The sewerage of the place is very imperfect; and there appears to be some trouble about the quality of the

public water-supply during the cold season, — just what, is at present unexplained; but, as far as situation and surroundings are concerned, Holyoke should be a healthy place.

Certain special cases of overcrowding have been noted down, from the records, as being rather curious instances of what close quarters people are at times obliged to live in. (The word "obliged" is used not from absolute knowledge of the necessity, but because it is incredible that people should be willing to live so under other conditions.)

Of the twelve cases mentioned of overcrowding, eight families were French Canadians, one German, and three Irish. Eight of these had health reports, of which seven are filled out as "some sickness." Would any one doubt it?

No. 1. — French; family of ten, who sleep in two small rooms.

No. 2. — French; family of five, who sleep in one room.

No. 3. — French; family of twelve, who sleep in two small rooms.

No. 4. — French; three families together, — five girls and three boys in one room, eight people in one room, four in one room, and two in another.

No. 5. — French; family of twelve, who sleep in two rooms.

No. 6. — French; family of seven, who sleep in one room.

No. 7. — French; family of seventeen, who sleep in four rooms; five sleep in one dark room.

No. 8. — French; family of nine, who sleep in one basement room.

No. 9. — Irish; family of seven, who sleep in one room.

No. 10. — Irish; family of six, who sleep in one room.

No. 11. — Irish; family of ten, who sleep in four rooms; four sleep in one bed in a room six feet by seven feet.

No. 12. — German; family of six, who sleep in one room with contents less than five hundred cubic feet.

No. 13. — Is a case of an American family, owning a brick privy accommodating one, which is "borrowed" by three other families.

Each circle on the following pages exhibits the facts obtained by a compilation of the returns of the sanitary survey of the ward there indicated.

The entire circle represents one hundred per cent. Beginning at the top with zero, and reading from left to right, the percentages can be easily obtained by comparison with the whole circle of the sector or arc to which a special name is affixed.

The facts thus shown are the following: —

Owner shows what percentage of the buildings is owned by individuals, and what by mill corporations.

Cellars shows the sanitary condition of cellars or basements of all buildings.

Privies shows the relative condition of these conveniences.

Water shows what percentage of the buildings is furnished with city water, and what depend on wells or cisterns.

Surface Drainage has reference to the ground underneath, and immediately adjoining all buildings.

Sewerage indicates the condition of the house-drainage for all buildings.

Nationality shows percentages of *families* of different nativities.

Number shows percentages of *persons* of different nativities.

Occupation shows the employment of all the inhabitants.

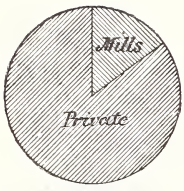
Air-Space shows the average number of cubic feet to each person in sleeping-room.

Garbage represents the percentage of buildings having decaying organic matter within them, or in the immediate vicinity.

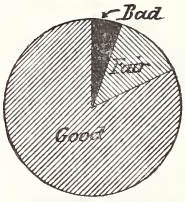
Surroundings shows the sanitary condition of the yards or grounds around the buildings.

Sickness shows the relative health of families.

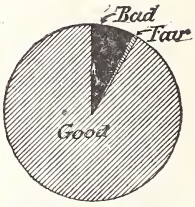
WARD 1



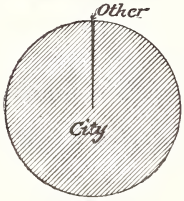
OWNER



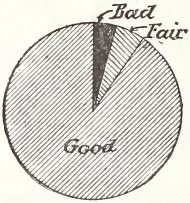
CELLARS



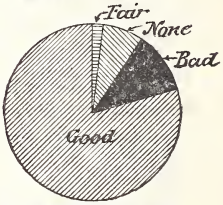
PRIVIES



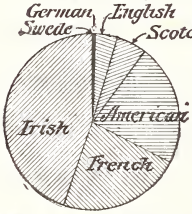
WATER



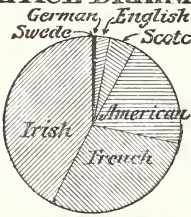
SURFACE DRAINAGE



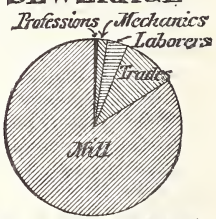
SEWERAGE



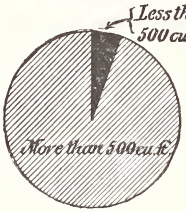
NATIONALITY



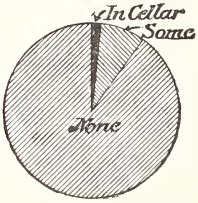
NUMBER



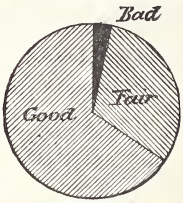
OCCUPATION



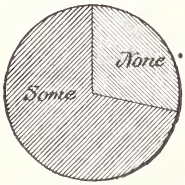
AIR SPACE



GARBAGE

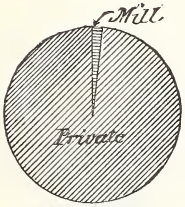


SURROUNDINGS

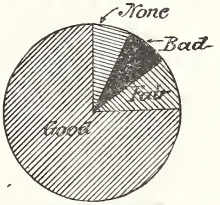


SICKNESS

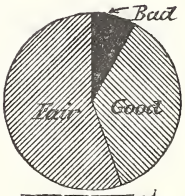
WARD 2



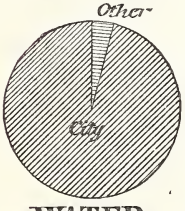
OWNER



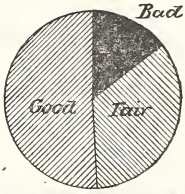
CELLARS



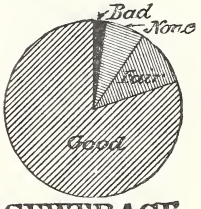
PRIVIES



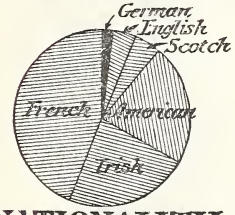
WATER



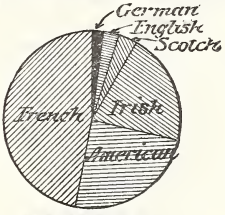
SURFACE DRAINAGE



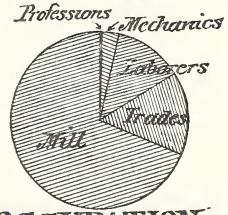
SEWERAGE



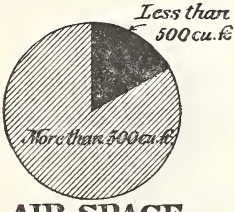
NATIONALITY



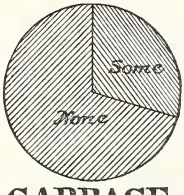
NUMBER



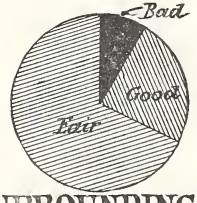
OCCUPATION



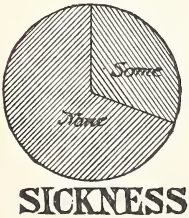
AIR SPACE



GARBAGE

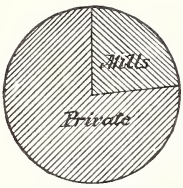


SURROUNDINGS

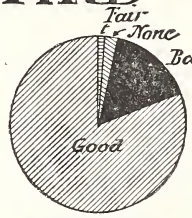


SICKNESS

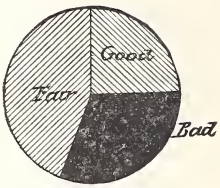
WARD 3



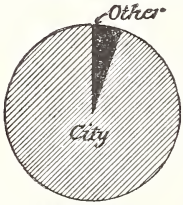
OWNER



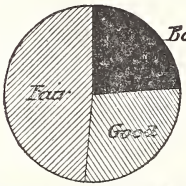
CELLARS



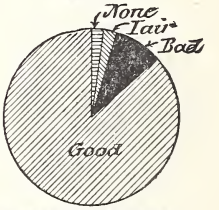
PRIVIES



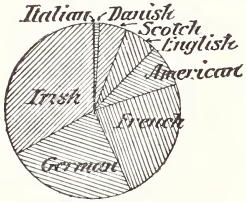
WATER



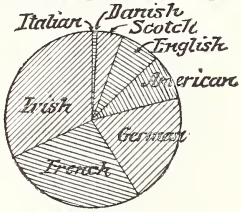
SURFACE DRAINAGE



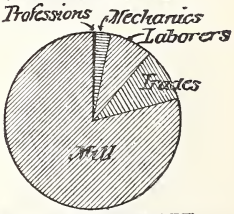
SEWERAGE



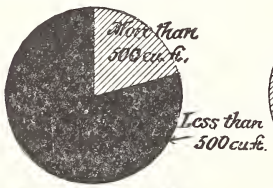
NATIONALITY



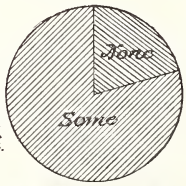
NUMBER



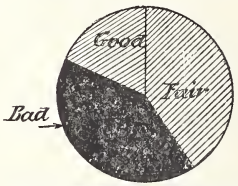
OCCUPATION



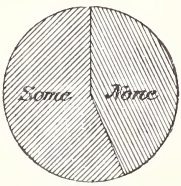
AIR SPACE



GARBAGE

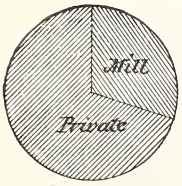


SURROUNDINGS

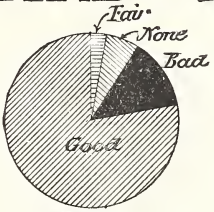


SICKNESS

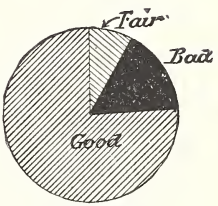
WARD 4



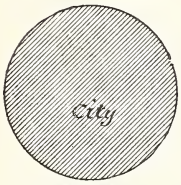
OWNER



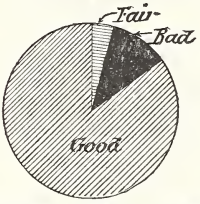
CELLARS



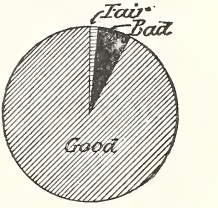
PRIVIES



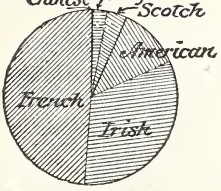
WATER



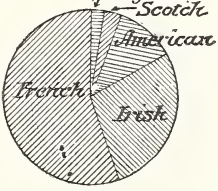
SURFACE DRAINAGE



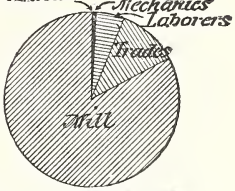
SEWERAGE



NATIONALITY

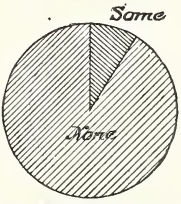


NUMBER

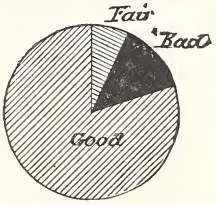


OCCUPATION

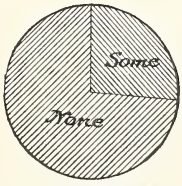
AIR SPACE



GARBAGE

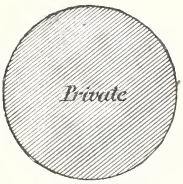


SURROUNDINGS

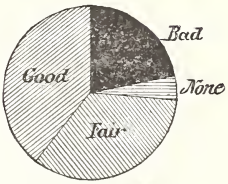


SICKNESS

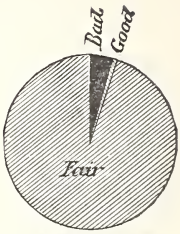
WARD 5



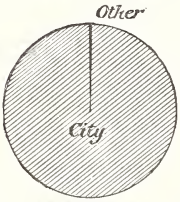
OWNER



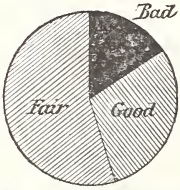
CELLARS



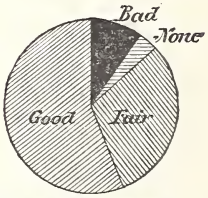
PRIVIES



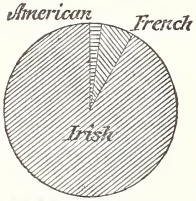
WATER



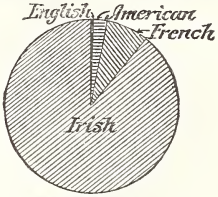
SURFACE DRAINAGE



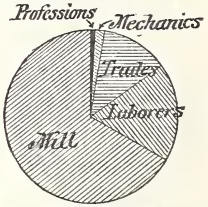
SEWERAGE



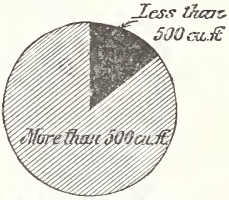
NATIONALITY



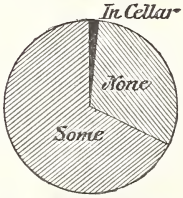
NUMBER



OCCUPATION

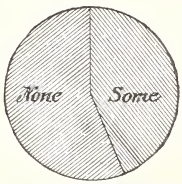


AIR SPACE



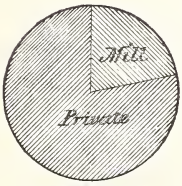
GARBAGE

SURROUNDINGS

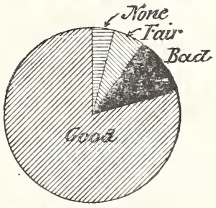


SICKNESS

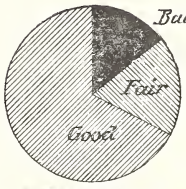
WARD 6



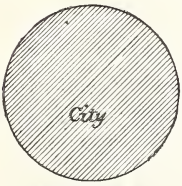
OWNER



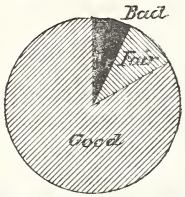
CELLARS



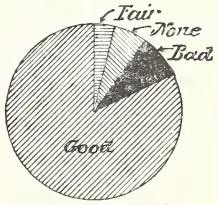
PRIVIES



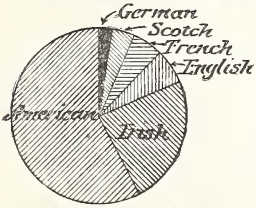
WATER



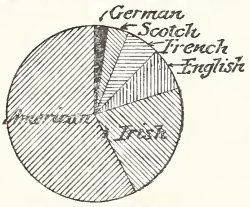
SURFACE DRAINAGE



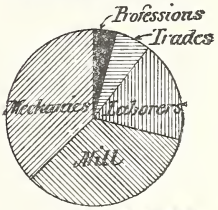
SEWERAGE



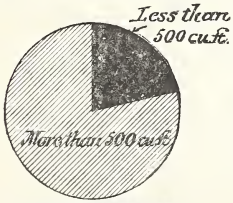
NATIONALITY



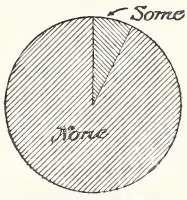
NUMBER



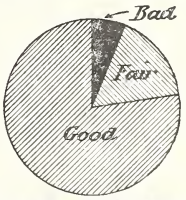
OCCUPATION



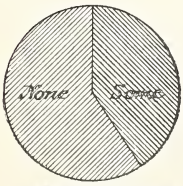
AIR SPACE



GARBAGE



SURROUNDINGS

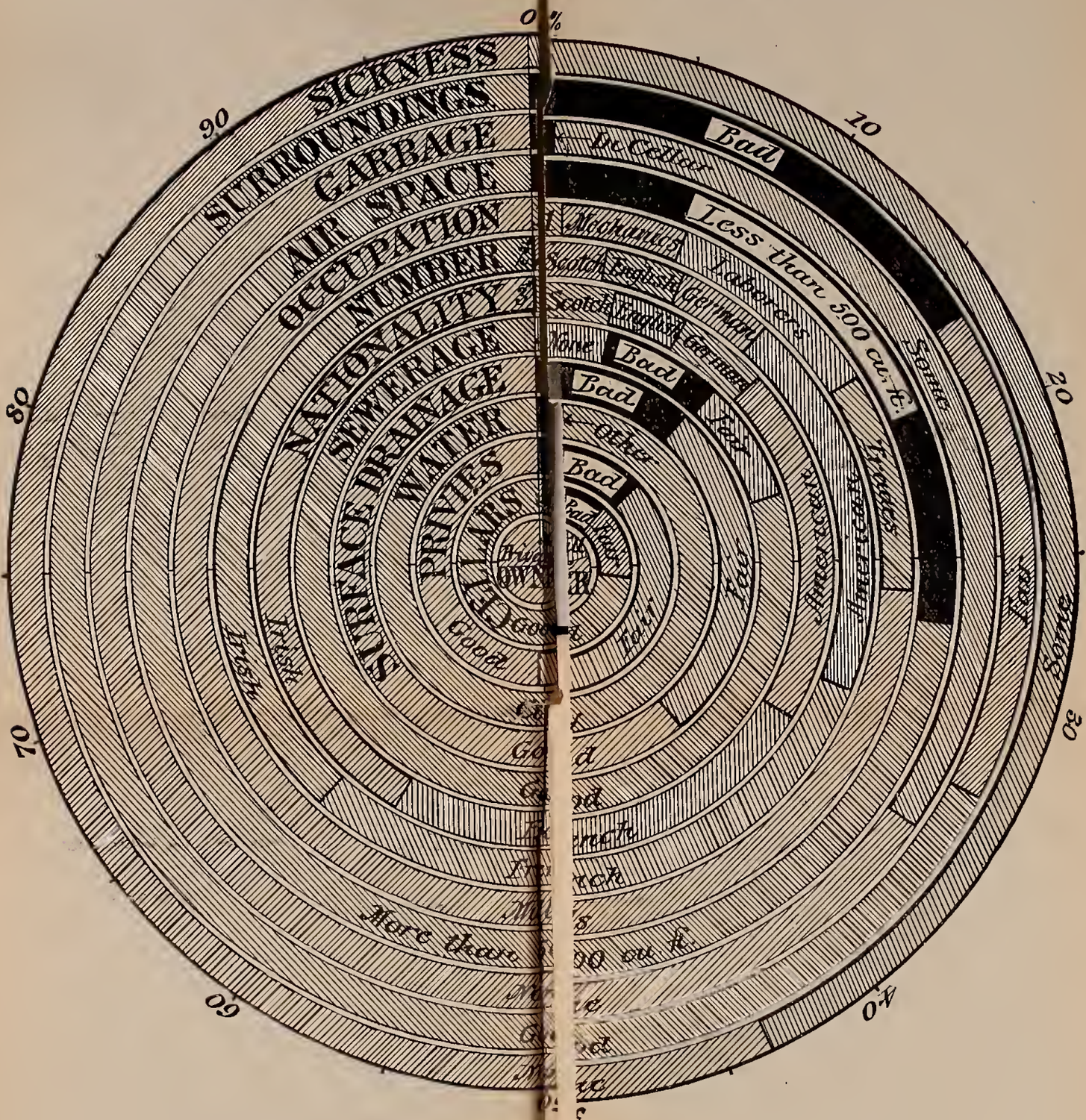


SICKNESS

The chart on the following page, showing the sanitary condition of the entire city of Holyoke, is a compilation of the records used in making the charts for the separate wards. The entire circle represents, as before, one hundred per cent; the different rings showing the same things that were previously covered by the separate circles and sectors in the various wards.

Beginning at the top with 0 per cent, and reading in the same way the hands of a watch move, the percentages will be easily seen, and understood for every case desired. Every 10 per cent is numbered on the perimeter of the outer circle; and the intermediate 5 per cents are shown by dots, also on the perimeter. A thread held at the centre, and moved around on the perimeter, will give the desired percentage.

SANITARY CONDITION



OF THE

CITY OF HOLYOKE

FOR 1880.

1 *Professions*

2 *Chinese, Italians, Danes, & Swedes*

3 " " " "

NEGLECT OF VACCINATION.

HOW SHALL WE TREAT IT?

BY

Z. B. ADAMS, M.D.,

FRAMINGHAM, MASS.

NEGLECT OF VACCINATION.

HOW SHALL WE TREAT IT?

In the early part of the year 1881, a personal examination of the schools in an important interior town of the State of Massachusetts, having large railroad connection with all parts of the country, revealed the somewhat surprising fact, that more than one-half of the children of nine years of age and under, attending the schools, had never been vaccinated; the practice of vaccination having apparently fallen into disuse since a period some nine or ten years ago, when the prevalence of an epidemic of small-pox called attention to the necessity of this safeguard.

The laws of Massachusetts upon the subject of vaccination cannot be called compulsory in any strict sense, but rather advisory. Sects. 27, 28, 29, 30, 31, of chap. 26 of the Revised Statutes, are still in force, as well as chap. 41, sect. 8: "The school committee shall not allow any child to be admitted to or connected with the schools who has not been duly vaccinated." Except in time of epidemic, perhaps, the sections of chap. 26 may be set down as inoperative. Of sect. 8 of chap. 41 we may say, as Mercutio does of his wound, "'Tis not so deep as a well, nor so wide as a church-door, but 'tis enough, it will serve."

In 1810 a law was passed making it the duty of towns to provide suitable persons to superintend the vaccination of the inhabitants. It has been claimed, on very reasonable grounds, that the change or repeal of this last law has been followed by neglect of vaccination.

In a "Report on Laws, Provisions, and Methods for securing General Vaccination," Dr. Elisha Harris, Secretary of the American Public Health Association, says, "Compulsory

judicial action, to overcome obstinate resistance to the duty of submitting to vaccination, occurs only as the unfortunate outcome of prejudice and ignorance." "Mere prejudice, that has resulted from the reported and exaggerated accounts of some accidental evil which has followed some careless kind of vaccination, is the chief source of opposition which sanitary authorities have to confront."

The object of this paper is not to discuss any of the mooted questions, such as that of frequent re-vaccination, of the merits of non-humanized lymph, etc. The point aimed at, and which seems of the highest importance, is that every physician be prepared to show, whenever the subject is broached, that "the objections raised to vaccination have no foundation in fact, and are disproved by the whole of the evidence on the subject."[1]

Men presumed to be thoroughly acquainted with the subject have written, and intelligent, cultivated, and influential men and women have said, that they would rather run the risk of small-pox than be vaccinated. It looks like begging the question to affirm that the only solid ground for such a view lies in the immunity conferred by vaccination. The truth is, that in this age of progress there is little respect for tradition; and small-pox is a tradition.

What is styled to-day an "alarming epidemic of small-pox" is a mere bagatelle when compared with the story of its ravages in the "good old times" before the days of vaccination. We do not sufficiently recognize the fact, that unvaccinated persons are found chiefly among the ignorant, the improvident, or the nomad classes, those generally living in the ill-favored tenement-house quarters of cities or in manufacturing districts. These classes comprise a very large proportion of those who refuse vaccination because of ignorance or prejudice, neglect it through carelessness, or have undergone the practice at the hands of incompetent persons. This explains why the crowded and foul neighborhoods are those where the variolous disease finds a nidus. This shows us how it is possible that a city may be reported to be overrun with small-pox, when physicians in large practice among the best families do not see a

[1] Report of the Committee of the British House of Commons. Parliamentary Paper No. 246, 1871.

single case. The "logic of facts of an epidemic" can have little force on the minds of men so situated. It is not surprising, therefore, that some of these have held that proper sanitary measures can control small-pox. How much more in our interior towns, remote from centres of contagion, may the opinion gain ground, *even among physicians*, that small-pox is a bugbear!

Let us then review, in as few words as possible, the salient facts, never to be forgotten or put out of sight, of the frightful history of small-pox.

The history of all epidemic diseases is pretty much alike. They were known for ages to the far Eastern nations. They seem to have remained shut within certain narrow limits until favorable conditions occurred for their growth and development.

As regards the etiology of the small-pox, we may properly assume this disease to be "a part of the plan of creation." The question of its epidemic appearance and presumed disappearance in a remote antiquity must be left to the archæologist.

Nothing authentic is known of small-pox until the present era.

In 1518 the island of St. Domingo was depopulated by the small-pox; and, soon after, in the city of Mexico nearly the whole population lay sick neglected, or dead, having no one to bury them (*no habia quien los enterrasse*, as quoted by Prescott). In 1563 it exterminated whole races in Brazil, one hundred thousand Indians in Quito: forty thousand out of a population of seventy thousand died in Çeará.

Catlin says that one-half of the Indians of North America died of small-pox. Alex. MacKenzie saw its ravages among Indian tribes. No flight, he says, was rapid enough to escape the infection, which was "as fire consuming the dry grass of the plains." The unhappy, frightened wretches slaughtered their wives and children, and committed suicide themselves, as the only means of escaping a loathsome death.

But it may be urged that these were barbarous or semi-civilized people. How was it among civilized races? In European countries it proved as great a scourge as death itself, as sure a leveller. Kings, princes, and nobles died by it in proportion to their whole numbers as did the lowly.

Down to the end of the eighteenth century all classes were resigned to the disease, because it was believed to be inevitable.[1]

A proverb ran in France, "From the small-pox and love few mortals can escape." Macaulay says it "is the most terrible of all the ministers of death."

In certain noted years of prevalence in Europe it destroyed half a million lives, in France one-tenth of the people, seventy thousand in England.

It was especially fatal to children: of those under five years old taken with it, two out of three only escaped death. In London, in fifty years of which records are preserved, one-third of all the deaths in children under ten were caused by this disease.

We have exact data from one continental city, Copenhagen. During twenty years one-eleventh of the entire population died every year by this means; and the surplus of deaths from all causes, over the births, in the time referred to, amounted to nearly twenty thousand.[2] Can we wonder that people speculated gravely on the extinction of the human race by the small-pox?

Nothing shows any difference in the course or symptoms or history of the disease to-day from what was noted a century ago. Epidemics recur as they did then. The unvaccinated are attacked and slaughtered to-day as they were in Copenhagen, and with about the same variations of epidemic virulence, and of time in the intervals, as then observed. True, we have now no communities of unprotected persons as formerly. We must go to the ends of the earth for examples. Some ten or fifteen years ago a small village in the island of Madagascar was visited by this demon of death. The whole village was swept away: none of the natives were left untouched, as is stated, all dying or flying. A few vaccinated ones, chiefly Europeans, staid to bury the dead,

[1] Speaking of Queen Anne's reign, Thackeray says, "Many a sweet face hath left its roses on the bed on which this dreadful and withering blight has laid them. In my early days this pestilence would enter a village, and destroy half the inhabitants. At its approach it may well be imagined, not only that the beautiful but that the strongest were alarmed, and those fled who could." "It spared the hall no more than it did the cottage." — *Henry Esmond.*

[2] In London, Paris, Dresden, Augsberg, Breslau, and other European cities of which we have the figures, there was every year an excess of deaths over the births.

who numbered about eight hundred. A similar story comes from the Gold Coast.

And not death alone, but a mutilation often worse than death, is left in the track of this Moloch of diseases. It was found to be the rule, before Dr. Jenner undertook to institute a new order of things and put a bar to such outrageous violence, that as the proportion of deaths so was the proportion of those maimed for life. Willan states that the results of severe small-pox in those who survive the disease are, ophthalmia, blindness, deafness, disease of glands, ulcers (often gangrenous) of the limbs, contraction and stiffness of joints, tumors and emphysema of cellular tissue, enlargement of bones, cough, dyspepsia, diarrhœa, and hydrothorax. To this list may be added sloughing of various parts, such as the scrotum, the eyelids, the alæ of the nose, etc. The list is a formidable one.

Sir Gilbert Blane states that two-thirds of the applicants for relief at the Hospital for the Indigent Blind were made blind by the small-pox. Not a whit less frightful, though less calculable, than this mortality and mutilation, was the moral and social disruption caused by great epidemics of small-pox in the cities of Europe in the seventeenth and eighteenth centuries. In these days of civilization and sanitation and vaccination, it is scarcely possible for us to form a conception of this evil. Some there were who trusted in the protection of a previous attack of the disease. These alone excepted, everybody, the wisest and best of the community especially, fled before the scourge. Their places were often taken by the reckless class who risked death to gratify cupidity or lust. The list of these wretches was constantly recruited from the large number of those whom poverty or necessity compelled to remain behind. License took the place of law. Duty and religion were alike forgotten. Trade was stopped, commerce forbidden, amusements abandoned. The greed of life destroyed all pure affections. Family ties, with those of home and kindred, were broken. There was no respect for the dead, little for age or honor. Idleness, debauchery, cruelty, and crime held high carnival, amid scenes as revolting as the sack of the Flemish cities by the Duke of Alva. When, therefore, people say they would rather run the risk of

small-pox than to be vaccinated, they betray an utter ignorance of, or indifference to, the facts of the subject.

It has been said, that, "if vaccination were as thoroughly and universally practised now as when it first appealed to the terrors of whole nations for acceptance, we should not hear to-day of doubts as to its efficacy."

While these facts are freshly in mind, let us inquire what would probably result, if for a term of years, say ten, the practice of vaccination should be discontinued or forbidden by law. And here it should be said that there is not an atom of evidence to show that any plan of any sort has been invented or put in use in any part of the globe whereby the spread of small-pox might be checked in the case supposed.[1] As we have no ground for hoping that the course of nature would be changed to suit the case, we are forced to admit that the result of this experiment would be as follows:[2] —

In populous districts one in every five, or throughout the State one in every ten, of children born during the time specified (healthy and vigorous enough to survive all ordinary diseases of childhood), would die miserably, covered with ulcerous sores, the body a reeking, putrefying mass, the features blurred beyond recognition by a mask of scabs, and very likely given to the care of strangers in its last moments. As many more would become maimed and mutilated for life; many being blind. Of those escaping death or mutilation, one-half would be scarred or shattered in health, and the remainder would live in constant terror of a new epidemic of this fatal and loathsome malady.[3]

Can any such case be made out against vaccination?

There may be Herods who will sneer at this prospect of the slaughter of the innocents, fanatics who will claim that the freedom of the race from the thraldom of vaccinia demands that the experiment should be tried. The student

[1] The utter powerlessness of drugs in fighting epidemics is admitted by all.

[2] In Massachusetts thirty-six per cent of all children die under five years of age; about five per cent die between five and nine years old. In London, as above stated, during fifty years of the last century, one-third of all the deaths of children under ten years old were caused by the small-pox.

[3] The ratios as here given are in truth much below what we might be fully justified in assuming from the record of small-pox epidemics before the days of vaccination.

of social science and economy, as well as the world at large, before running the risk, will demand proof of the hurtfulness of vaccination much stronger than any that is yet forthcoming.

In the city of Boston in 1721 one-half of the population lay sick of the small-pox at one time. It passes the wit of man to conceive of any measures or treatment that could be devised, or, if devised, could be carried out (vaccination of course excepted), should an epidemic of like proportions occur to-day in one of our cities. Imagine, if you can, a hundred and eighty thousand cases at one time in Boston.

The virulence of the epidemic of 1861 in that city was proved by the fact that the proportion of deaths among the unvaccinated was much higher than in the epidemic of 1721. It is then pertinent to ask, what reason, except the existence of the practice of vaccination, can be shown for the fact that the total of cases in 1861 was less than two thousand instead of ninety thousand, — i.e., one-half of the then population? (Dr. ROBERT WARE: *Report on Small-pox*, read before the Boston Sanitary Association, House Doc. No. 153, March, 1861.)

The case is thus stated, because investigation has proved to the writer that the neglect of vaccination in the country towns is due chiefly, if not entirely, to ignorance of the whole subject, or to doubts of its importance and urgency. The school committee have neglected to enforce the vaccination law because there is no one to ask for its enforcement, and because they thought it the duty of parents to see that their children were vaccinated. Only very rare cases have been found where parents have objected to vaccination; and, in the presence of an epidemic, the number of these will be diminished to a proportion which may be disregarded. In vaccinating those attending the schools we secure, in nearly all cases, the vaccination of those members of the same family too young to go to school.

There is, however, one danger which should not be overlooked. Immunity from, or at least freedom from, attacks of small-pox, might, in certain localities, continue in spite of non-vaccination; in which case, instead of being attributed to its true cause, this might be used as an argument to prove the needlessness of the practice.

It is not necessary, it might be disastrous, to excite antagonism by introducing stringent and compulsory legislation. The practice must not be rendered odious. Occasional notice of the matter is enough. A little agitation of the subject, and its intelligent discussion, and thorough sifting, is the true way among a people so enlightened as our own. To wait for epidemics in our midst, is dangerous, is unwise. Every physician, therefore, should be thoroughly armed to meet all the arguments of the anti-vaccinators.

The first of these arguments is, that vaccination does not protect. And here two important facts should be noted: *First*, it was well known before the days of vaccinia that a favored few escape the small-pox, though repeatedly exposed to it; and we now find a small proportion of mankind, say one in seven hundred or eight hundred, not susceptible of vaccination. The latter do not, however, necessarily escape small-pox. *Second*, a small fraction of mankind have such a susceptibility to the disease, that neither repeated attacks of small-pox, nor repeated vaccinations, nor both combined, have availed to protect them. Between these two extremes lies the great bulk of mankind, manifesting, doubtless, every shade of susceptibility or of immunity; and it is to them that the question should be put.

Does Vaccination Protect?

The best evidence, perhaps, is found in the small-pox hospitals. Mr. Marson, during forty-one years of service in the London Small-pox Hospital, never knew any one of the nurses or servants to take the disease, although in the closest and most constant attendance upon those sick with it in the course of several virulent epidemics; all the nurses and servants being subjected on entrance to the process of vaccination, whether previously vaccinated or not. Similar evidence comes from the great small-pox hospitals everywhere. Now, at the present day we seldom find nurses or servants who are protected by previous attacks of small-pox. Can we imagine that any thing, except the fact of their vaccination, gives these people such immunity from the disease, when they live in the midst of it?

Armies have always been a favorite prey of the small-pox. In the Prussian army vaccination is well-nigh univer-

sal. The same is true in great measure of the British army and navy, and of some other armies. Those mentioned have often been quartered in the midst of small-pox epidemics; the Prussians in many cases in crowded barracks, in infected districts, in large cities, the soldiers freely mixing with the people. Yet these soldiers have, in the cases mentioned, repeatedly escaped infection, showing no form of variolous disease. In twenty years only four fatal cases occurred in that large army among the re-vaccinated.[1] Prussian army medical statistics do not admit of question; and the conclusion seems inevitable, that, the more you are vaccinated, the more you are protected.[2]

Again, it is claimed that vaccination inoculates pox, both small and great, as well as other diseases. The best case is made out against syphilis, the others being by no means clear. One would suppose, from the easy confidence with which this statement of syphilization is made, that the thing was frequent. Who among us has ever seen a case of vaccinal syphilis? The testimony of men who have vaccinated hundreds of thousands is, that they have never seen one. Let us admit without question that the facts are as stated, and then look at the millions of vaccinated persons in the world, and ask if the chance of some error in the observations is not much greater than one in hundreds of thousands?[1] Is not the danger reduced to nothing where bovine virus is used?

We must remember, in a doubtful case, that parents are of course anxious to account for the presence of syphilis in their offspring by any thing that happens to them rather than by hereditary vice of the blood, and also that the belief in the transmission of syphilis by the vaccine lymph is opposed to, 1st, the evidence of the greatest vaccinators; 2d, that of the syphilographers; and 3d, that of pathology, i.e., the ex-

[1] A similar statement is made concerning the British troops in the West Indies.

[2] It seems to be forgotten or overlooked that the protective virtue of the kine-pock was proved to the satisfaction of the world by Jenner himself. This was done by practising the inoculation of small-pox virus upon all who had received vaccination. The crucial character of this experiment no one could deny. It was tried, it is said, by Jenner and others in thousands of cases, and with the same invariable result. It is, however, maintained, but not yet proved, that the protective power of humanized lymph has diminished since Jenner's time.

periment of using lymph taken from syphilized vaccinifers. Bovine matter, too, is said to have occasionally produced phenomena resembling vaccinal syphilis.[1]

Another claim is that many diseases, especially of children, not directly imparted by vaccination, have in some way become more frequent and fatal as a result of its practice, — that the poison of small-pox checked in one direction has taken another form of development. In a paper on "The Increase of Human Life," by Dr. Edward Jarvis, read before the American Statistical Association in 1872 (which, as it does not in any way touch upon the subject under discussion, we may properly quote), it is stated that measles, convulsions, disorders of teething, and other maladies of childhood, as well as fevers and consumption in all ages, have greatly diminished in fatality during the last fifty years. This in London and in Massachusetts.

Again, it is claimed that vaccination depraves the constitution, diminishes vitality, and thus renders the individual an easy prey to disease, and shortens human life. A French writer, Verde de Lisle, says, "Vaccination has caused mental and physical degeneration of the human species, diminishing men's stature; incapacitating them for the fatigues of military service, or even of the exercise of dancing." If this degeneracy could be proved, the relation of cause and effect to vaccination can be found only in the vivid imaginations of the opponents of the practice. But what is the fact? Dr. Jarvis, in the paper just cited, shows in the most convincing way that there has been a decided increase of human life in the present century, which he attributes justly to greater diffusion of knowledge and of wealth, and to the improved opportunities of health and comfort enjoyed by the lower classes.[2]

Mr. Babbage, in his work on Life Assurance, says that Davillard has shown that vaccination has increased the mean

[1] In a report of the American Public Health Association, syphilis is stated to be communicable as follows: By blankets, sheets, etc., in hotels and sleeping-cars; cups, forks, knives, etc., in public houses; public drinking-cups; barbers; surgeons and dentists; toys; utensils used by servants, and not washed; playing-cards; smoking-pipes. It would not be surprising if disease arising from one of these causes has been attributed to vaccination.

[2] "The age of machinery has made it easier to supply the wants of food, clothing, and shelter:" a marked increase is thus produced in the comforts and also in the intelligence of the masses.

duration of human life by about three and one-half years. Premium-rates are influenced accordingly.

In art and science, in philosophy and literature, in engineering, in invention and exploration, in travel and war, in short, in every department of human thought and action, we have made immense progress since the general use of vaccination began.

A list of the names of those most prominent in their various *rôles* in the drama of progress of the last seventy or eighty years would be too long. We may rest assured that it would be vastly shorter but for the protection against the small-pox conferred by Jenner's discovery. Does the practice of vaccination cause degeneracy in the human race?

In answering this question we fortunately find ready at hand a great block of humanity, vaccinated, and re-vaccinated, and vaccinated again, for the last forty-five years. Happily also we have the rare opportunity offered us to contrast the achievement of an army so vaccinated with that of another army contending against it in which it is notorious that the practice of vaccination had been very imperfectly carried out, and by no means systematically enforced. This is no exaggerated description of the condition of the armies of Prussia and of France with regard to vaccination. What doubt can arise in the mind of any one as to which of the two armies displayed most conspicuously the soldierly qualities of discipline, endurance, courage, etc., during the Franco-Prussian war?[1]

Another argument, which indeed appears the strongest argument against the practice of vaccination, is that many vaccinated persons in time of epidemic take the small-pox.[2]

This opens the question of imperfect vaccinations, and the importance of re-vaccination to insure protection, upon which it is not the purpose of this paper to enter. We will look at the question in another way.

The proportion of the unvaccinated in London and other large cities is placed by writers at four per cent. Ninety-six

[1] The French lost by small-pox nearly 23,000; the Prussians 250, in round numbers, from the same cause. The Prussian army was the more numerous, and must have been quite as much exposed as the French to the influence of the fatal epidemic which prevailed during the war.

[2] In small-pox hospitals a majority of the patients can usually show more or less well-marked scars or other evidences of vaccination.

out of every hundred are vaccinated. Until we can show, therefore, in the records of epidemics, *and with large numbers of cases*, some approach to this figure in the proportion of vaccinated persons attacked by small-pox, we may rest content. At present we may insist upon the fact, not yet successfully disproved, that the fatal cases, and the mutilated, are much commoner among the unprotected than among the vaccinated in proportion to the numbers of each; this showing that even imperfect vaccinations confer a degree of immunity.

Wherever any doubts of the efficacy of vaccination are based upon facts of the kind now under consideration, it is safe to assert that the practice has been imperfectly carried out, this being only a corollary of what has been already shown of the known facts of small-pox and vaccination.

The anti-vaccinists seem to lay much stress upon an observation made by Jenner himself, that the matter of "the grease" (a disease in the foot of a horse) may be the original source of vaccinia. One says, "It [vaccination] is an Englishman's remedy, and Englishmen have a pride in ingrafting their beastly virus." With delicate and sensitive minds this statement doubtless has weight. It should be generally made known that vaccine lymph is a limpid, odorless liquid, without offensive qualities.

With some persons the saving of money is an argument. It has been estimated, that, allowing $100 as the cost of care of a case of small-pox, the annual loss by variola in this country is $2,238,000, with lives valued at $50,000,000 more. Dr. Benjamin Lee estimates the total loss in money to the city of Philadelphia, during the epidemic of 1871–72, at $23,000,000. He finds that 90 per cent of the cases and 97.5 per cent of the deaths could have been avoided by stringent vaccine regulations, when less than $750,000 would have represented the total loss by sickness, death, and disability.[1]

In 1871, in England, an anti-vaccine excitement, fomented by the distribution of pamphlets asserting disputed facts as though they were established truths, brought the matter before the British House of Commons. A very large commit-

[1] Averaging the value of a human life, he finds the actual loss in that one epidemic in the city of Philadelphia to be about $16,500,000.

tee, including men of all shades of opinion, was chosen to hear the arguments and report upon them. Eight days were devoted to hearing, and one hundred and fifty-two pages of the official Blue Book to recording, all the evidence on both sides; and the result was an humiliating defeat and complete overthrow of the forces of the opponents of vaccination. The report of that committee, which is long and covers every point, furnishes the most thorough vindication of the practice that can be found in any literature.

The late Dr. George Derby, when Secretary of the State Board of Health, wrote: "Nothing, however beneficent, can escape the criticism of the times in which we live. The criticism of vaccination, often passionate and violent, relates chiefly to points which, however interesting they may be, leave the main question unaffected. We may speculate about the possibility of the potency of vaccine being exhausted in the human family; we may be surprised to find that people with good vaccine scars sometimes have small-pox; we may dispute as much as we please about the average period when re-vaccination may be considered a prudent safeguard; we may even conjecture (what no man has proved) that other diseases than that of the cow may be communicated by humanized vaccine; but after all we find that we rest in a security against this most horrid pestilence unknown to former generations."

We have abundant evidence to show that improvement in the sanitary condition of cities has no perceptible effect upon the course of small-pox epidemics. In the city of New Orleans great improvement of sanitary regulations prevailed in the years succeeding the war of the Rebellion. The city was subjected, as it never had been before, to a costly and so-called thorough system of disinfection and sanitary inspection. Yet during epidemics in 1870, 1873, and 1874, the mortality from small-pox was greater by many times than in those which prevailed *previous to the war*, and this in defiance of every effort of the sanitary authorities. (J. Jones, *N. O. Med. Surg. Journal*, January, 1878.) It is well known that cold weather intensifies the disease.

Doubtless there are many honest and astute minds in our community who are anxious to be among the first in every step of reform. To such there is a charm in the declaration

that vaccination is an imposition on mankind. Their watchword is, "No interference with the liberty of choice." The anti-vaccination pamphlets which have fallen into the hands of the present writer must be a disappointment to every fair-minded and thoughtful advocate of reform. They garble quotations from authorities on the subject; they quote from those who are not authorities. They recite gossip. They have all the bitterness of tone of special pleading. Some, indeed, seem to be written solely to advertise their author, and his new mode of treating small-pox. The arguments have been already considered. What shall we say to assertions like the following? —

Vaccination is a scientific absurdity, a snare and a delusion, a curse to the race. It is advocated by those who make money out of it, and practised by those who blindly follow in the beaten track of the regular schools of medicine.[1] It requires "courage transcending any common audacity to take issue with a popular idea," says one writer; and, on the next page, "As in the case of other notions which have not commended themselves to popular acceptance, its advocates do not submit it to rational inquiry, but seek to enforce it by law," etc. No dogma based only on antiquity and mystery can stand before the advance of science, says one; and in the next sentence declares that vaccination has no antiquity to recommend it. "It is the hobby, rather than the conviction, of the medical profession."

The category of diseases attributed to vaccination as a cause by the anti-vaccinators is something amazing.[2] The most complete evidence which could be obtained upon this head was brought before the select committee of the British House of Commons in 1871, to which reference has been made above. The resolve touching this point in the report of that committee reads as follows: —

"9. The danger, if there be any at all, of communicating in a properly performed vaccination any other infection than

[1] This is open to the retort, that some physicians may be found to decry vaccination for the sake of notoriety, or because the rewards are not proportionate to the trouble of the practice.

[2] There is scarcely a disease known to the human family, that is not included in this list. It has been said that "vaccination has nothing to fear from so much as the injudicious zeal of its friends;" and the saying applies with perhaps greater force to anti-vaccination.

vaccinia, is so infinitesimally small, that, for all practical purposes, it may be regarded as non-existent."

After all, nothing will justify legal interference, nothing will satisfy common sense or scientific inquiry, like the assurance that vaccination will protect. Probably there will always remain a small fraction of mankind either insusceptible of vaccinia, or in whom it affords no protection against small-pox. Common sense will make allowance for this; science may perhaps restrict the number; while law is made for the general, and not for the particular. It remains for art to secure for medical science, as far as possible, this certainty of protection, if we would prevent vaccination from falling into disuse, and perhaps contempt. The following plan seems feasible and likely to succeed.

1st, A State vaccine establishment, the chief business of which shall be to propagate vaccine lymph by animal transmission, or perhaps by artificial methods (as Mr. J. Lawrence Hamilton of London proposes), and from which all the physicians in the State shall be supplied. This lymph must be proved by constant testing; and the recipient must be required to report his results, and acknowledge receipt, ten days after date. With the matter should be sent a recommendation to the physician to vaccinate, if possible, every infant born in his practice within —— months after its birth; also such instructions as may best prevent imperfect vaccinations, which are the opprobrium of the system as now practised.

2d, Vaccination to be forbidden by law, except by the hands of those to whom lymph is intrusted by the institution.

3d, Annual examination by officers of the institution, or its appointees, of the schools of the Commonwealth, with two objects: first, to secure uniformity of results, and report and tabulate all exceptional or irregular cases; second, to disclose any neglect on the part of the school committee to enforce chap. 41, sect. 8, of the Revised Statutes.

4th, A note of advice sent annually by the institution to the Boards of Health recommending re-vaccination of every child on reaching the age of ——. This is to be enforced by the school committee, with additional legislation for the purpose if found to be necessary.

5th, Notice to re-vaccinate whenever the protection of public health requires.

6th, Notification to superintendents or other officers of incorporated manufacturing companies, etc., that the regulations of chap. 26, sect. 30, of the Statutes, are in force, and must be complied with.

7th, An annual or biennial report from the institution, to be published in the public prints, calling attention to the subject, detailing experiments, methods, and results, and mentioning towns, cities, or manufacturing corporations where neglect of vaccination is found.

It may be that we have in the prophylactic power of vaccination the germ of a general law or principle applicable to other diseases besides the small-pox. This is not proven, but not improbable. Meantime vaccination must remain a law to itself. Until a discovery is made of analogous facts in other diseases, the plan here proposed seems the true method of arriving at the principle which governs the phenomena.

If this plan can be carried out faithfully for a series of years, we shall gain two or three points of prime importance. 1st, Many vexed problems, the solution of which science can obtain only from systematized art, will be resolved. These problems are, many or some of them, certainly capable of answer, if not of complete solution. What constitutes a perfect vaccination? and, What the significance of the imperfect re-vaccination sore-arm? are among these questions. 2d, Again, we shall not have to wait for epidemics to compel us by their cruel logic to submit ourselves or our children to the practice. 3d, No one will think of shrinking, as is now often the case, from contact with small-pox or varioloid. 4th, There will be no such thing, at least in Massachusetts, as a vaccine famine, like that seen in Philadelphia, in San Francisco and Sacramento, in the midst of an epidemic. These things we may confidently hope for; but that the last word will ever be said about vaccination or small-pox, we cannot expect until the millennium.

INDEX.